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AGRICULTURAL ENGINEERING

VOL 17, NO 1 EDITORIALS JANUARY 1936

Farm Products, Not Farmers, for Factories

PRESS REPORTS from the current meeting of the American Association for the Advancement of Science quote Dr. Jacob G. Lipman, Rutgers University, as having said:

"We can vision the gradual development of two types of farming in the United States. . . . Commercial farming will utilize all the expedients of science and technology, . . . business organizations and management. These large farms will be held either by corporations or by farmers' cooperatives.

He mentions as "questions" farm products in the manufacturing of fuels, plastics, celluloses, organic acids, high alcohols, and what not; and the "distribution of population as it may be affected by large-scale farming on one hand and part-time farming on the other." Besides changes in taxation and other economic relations he suggests that:

"Industry will draw an increasingly greater part of its employes from families living on small farms, and deriving a large part of their living from them."

All of this seems to sound the doom of the self-contained, self-sustaining family farm in America. With the large-scale, highly-organized farm held by corporation or cooperative, if it proves itself economically, a wholesome standard of living and social relationships for the farm family probably can be worked out. If the somewhat feudal values of the integrated farm business, home, and family are to pass, acceptable substitutes may be evolved, though it will take statesmanship to accomplish.

Toward the part-time farm we feel no such complacence. Granting the freedom of any individual to combine urban employment with rural living, and to pursue a petty agriculture as an avocation; taking into account also the social desirability of a human link between industry and agriculture; nevertheless the part-time farm as any considerable part of our economic fabric seems fundamentally a threat to what we deem desirable human objectives, such as high and well-distributed levels of income, short working hours with ample leisure, and highly skilled labor efficiently applied.

The part-time farm and the subsistence farm are sisters under the skin. It is no compliment to our statecraft and our industrial leadership, if they must look for individual security by way of factory hands who practice peasantry to escape starvation in dull times, and to eke out existence when mass production booms. With unemployment promising to continue as a major problem in the face of normal levels in production and trade, it is no solution to admit a system in which men double in farm and factory.

A man who boards himself by farming is bound to become a cut-throat competitor for employment against fellow-craftsmen who try to live by their trades alone. He may be equally an unfair competitor of the legitimate farmer. With farming already so technical and complex as to tax the knowledge and intelligence of specialized farmers, the demi-farmer will be less capable, less fit to serve as steward of our national resources as represented by land and soil. And these are but a few of the implications.

Mere "viewing with alarm" will not forestall such developments if they should become economic. A highly engineered, highly efficient type of legitimate agriculture probably can make part-time peasantry economically hopeless. In so doing, agricultural engineers will serve not only agriculture, but every type of work and employment.

Doctor Ladd Looks Forward

WELL WORTH mention in their own right, and of added interest for comparison with the Lipman prophecy, are the views of Dr. C. E. Ladd, dean of the college of agriculture and director of the agricultural experiment station at Cornell University. In welcoming the ASAE North Atlantic Section to Ithaca for its meeting of last October, he voiced the opinion that in the course of the next two or three decades:

1 Every farm in *permanent* production would be on a hard-surface road.

2 Practically every farm would have electricity.

3 There would be a great deal more tile drainage than at present.

4 Farmers would be doing a great deal more with tractors and trucks.

5 Farmers would be taught to do concrete work that would be more permanent. (He commented on the extent to which concrete has been badly managed and its values not realized.)

6 From the need for hauling heavy truckloads would evolve some satisfactory, yet not too expensive, type of roadway for intra-farm roads or lanes.

7 An increasing amount of permanent construction on farms.

Naturally Dr. Ladd was speaking mainly of the things for which agricultural engineers will be responsible, and in terms of the northeastern states especially. But from the vantage point of an old farming area, as time goes in this young nation, an area which has led in progress toward a permanent agriculture, and which in climatic and soil conditions is broadly representative of many other states, his seasoned judgment takes wide significance.

While nothing that Dr. Ladd said specifically excludes the idea of hybrid farmers and industrial workers, there is utter absence of any hint in that direction. Surely New York state is well enough dotted with industrial cities, great and small, that he would entertain the possibility were it economically and psychologically feasible, or socially desirable.

The emphasis he puts on permanence needs no comment. It is logical for a maturing agriculture. But his stress on transport, within and without the farm, would seem to envision tonnages far in excess of present practice. Perhaps he, too, feels that the next era in farming is that of mass production of raw materials for industry, in which transit from field to factory will be a major economic problem.

Safety Engineering for Agriculture

WHEN President W. C. MacFarlane of the Farm Equipment Institute addressed a joint meeting of the ASAE Power and Machinery and Rural Electric Divisions last month, he proposed safety as one of two or three main objectives to be emphasized in the immediate future evolution of farm machinery. Probably it is more than coincidence that the research department of the Institute now contemplates a serious study of farm accidents, with relation particularly to farm power and equipment. It seems obvious that agricultural engineers will applaud the purpose of such study, aid it in appropriate ways, and use its findings to guide their work.

With the National Safety Council, the statistical departments of accident insurance companies, and sundry agencies of government, state and national, there should be enough of existing machinery and pre-existing records to pursue the statistical phases of such farm safety studies without assigning to our profession a job for which it is not especially adapted. Yet we hasten to add that any and all agencies so acting should draw on agricultural engineers as technical counsel in planning any special investigations, evaluating date, and arriving at conclusions.

Lacking such guidance, statistics have a way of reaching conclusions like that made famous by Mark Twain—that beds are the most dangerous of all places, because deaths in bed outnumber all others combined—or the appalling perils of stenography revealed by an average death age among its practitioners of less than thirty, contrasted with the safety of being a bank president, wherein the average death age is around sixty. The engineer may have no monopoly on logical thinking, but in agriculture he best combines with it a seasoned judgment of method and equipment.

In farm machinery, for example, he is more likely to resist the temptation toward considering accidents on a per capita, per annum, or per hour basis, and cut through to the significant basis—acres of work accomplished, or units of crop produced. In terms of national welfare, that machine or method in wheat growing is safest which produces a million bushels with the smallest number of casualties.

Nor should it be forgotten that accidents involving machinery often are interlocked with the design of buildings or fences, practices in animal husbandry, and other factors in the overall conditions. Many of these are embraced in the integrated profession of agricultural engineering, and with all of these agricultural engineers are well articulated through cooperation with other agricultural scientists.

Electrical Safety for Livestock

ANOTHER phase of safety engineering in agriculture ready for study is that of electrical hazards to animals, and also human and fire hazards as they appear to differ on the farm from what prevails in the urban scene. Primarily a job for the rural electric engineers, it extends into the realms of buildings and machinery.

The amazing case in which a potential no greater than 17 volts was fatal to a cow, opens up the susceptibility of domestic animals to electric shock, and brings into question the whole question of grounding in farmstead practice. With such things as milking machines, water systems, refrigerating plants, and any equipment involving pipe lines, the machinery engineer is involved no less than his electrical brother.

While we do not suggest any hasty adoption of a sacred code (we almost said "cow"), there is every reason to press forward along the electrical safety route now while the movement for greater economy in farm wiring is active. Constant correlation of the two will prevent false starts and give more of stability to such progress as is made.

On Those Who Lament Machinery

IN THE COURSE of a personal letter not written for publication, ASAE Past-President Leonard J. Fletcher gave expression to some views which deserve a wider audience. He was commenting on " . . . . . . that most interesting and typical reaction of so many men who have farmed, but years ago left the farm for other work where they lead an office or white-collar existence.

"Memory is kind. After the picture of long hours, hard toil, cold and heat, dust and mud has sufficiently faded, the view from an enclosed automobile of a farmer driving a fine big team over a beautiful field causes the heart of such individuals to swell and their lips to curse the demon machine that tends to change this scene.

"The human family has literally flown in its rate of technical or scientific development, while creeping along in developing its ability to use, or its viewpoint towards, the work of the technologists.

"We have developed the machine. It is possible to have a better existence through its displacement of human toil. Our civilization is built upon it. If anyone just cannot stand it here with our machines, he can find places in the world where there are none. I prescribe therefore for such cases a one-way ticket. There will not be much demand.

"Those of us who elect to stay here must constructively attack the job of learning how to secure the maximum of real service from mechanization."

Measurement of Forces on Soil Tillage Tools

By A. W. Clyde

AGRICULTURAL ENGINEER, PENNSYLVANIA STATE COLLEGE. MEM. ASAE

TILLAGE TOOLS have been developed to their present stage largely by trial-and-error methods. There has been little if any information available as to the forces acting on the tools, therefore the designer has had to be guided mostly by experience and judgment. To supply basic information as to the forces being dealt with, the Pennsylvania Agricultural Experiment Station is studying the soil resistance encountered by tillage tools and the relation of this force to other forces on the tools. The object is to get information for engineering design on (1) mechanical strength and rigidity, (2) best location for the pulling force, and (3) the effect of different shapes and angles of tools.

Mechanical Strength. Rational design for strength and rigidity cannot be expected if the forces to be resisted are only vaguely known and if their position and direction are doubtful. For example, if we want to distribute the metal in a spring cultivator tooth to obtain the greatest strength, the first step should be to find out the bending moments at various points. That requires that the soil force on the tooth be known. Also, if we are to design a bearing of a disk harrow or its support, we should know what the total load is and how it is divided between radial and thrust components.

Hitching. It was pointed out in a previous paper[1] that the forces on any tool are in equilibrium, and that for uniform motion the forces always present are the weight, the pull, and the resultant soil force on the tool. Other forces sometimes present are inertia, power take-off torque, a force supplied to a trailing load, and possibly a little air resistance. The pulling force is intimately related to the other forces. Therefore, its position and direction can only be selected intelligently with knowledge of the other forces. Some of the information on hitching in college bulletins and in machinery instruction books is incomplete or wrong because it does not take into account all the forces on the implement.

Effect of Shape of Tools. Examples of this are the effects of different shapes of plows, different angles for cultivator shovels, sharp as compared to dull cutting edges, and various shapes and angles for disks.

We do not mean to imply that machinery design in any of the above respects can be entirely a matter of calculation without the use of judgment. We believe, however, that the knowledge of the forces on implements will be of great assistance to a designer and should result in tools that do more satisfactory work, are more durable or are more economical to manufacture.

NATURE OF SOIL FORCES

Soil is a highly variable material, and this variability appears in the resistance offered by it to tillage tools. We have not attempted to control soil conditions as is being done by the Alabama Agricultural Experiment Station and the USDA Bureau of Agricultural Engineering. Rather we are making tests under conditions varying from easy to difficult so as to know the range of forces which a tool might encounter. For this reason we are not much concerned with great accuracy of measurement. An error of 5 per cent from the true value seems of no consequence in measuring and locating a force, when soil conditions are not controlled and when judgment will be required in applying the data to implement design. We are, however, getting data on soil variables so that results can be correlated to some extent with the work done in Alabama.

Correct thinking in regard to soil forces is helped, if a distinction is made between what may be called the useful and the parasitic forces. A useful force or resistance is one which a given tool must overcome in cutting, breaking, and moving the soil. For example, the soil force on the working face and edge of a plow is useful. The parasitic forces are the supporting forces with the friction drag occasioned thereby, whether such forces are carried on sliding surfaces or on wheels. Such forces, including the forces on a plow landside, are only necessary evils to stabilize the implement,

Presented before the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1935. Authorized for publication on November 23, 1935, as Paper No. 708 in the journal series of the Pennsylvania Agricultural Experiment Station.

[1]"Vertical Hitching of Farm Implements," AGRICULTURAL ENGINEERING, vol. 16, no. 9, September 1935.

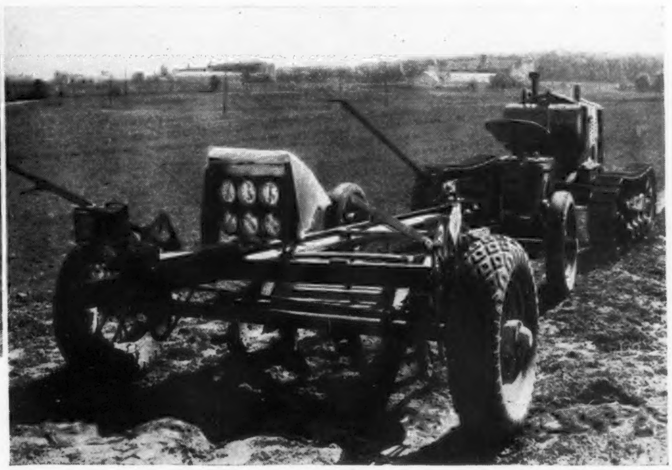


FIG. 1 (ABOVE) THE PULLING METHOD APPLIED TO A DISK HARROW GANG. FIG. 2 (RIGHT) THE TILLAGE METER ARRANGED FOR TESTING A GROUP OF CULTIVATOR SHOVELS

and their magnitude can largely be controlled by the design of the tool or by the location of the pulling force. Figures given later for plows and cultivator shovels are for the useful forces and do not include friction drag of supporting wheels or landsides. In the case of a dull share or shovel, however, it is very difficult to separate the parasitic force on the under side of the edge from the useful force, except by comparing tests with dull and sharp edges. For disk harrows it seems difficult to distinguish between useful and parasitic forces, except that the draft of a forecarriage would be definitely parasitic.

On a symmetrical tool, such as a cultivator shovel or lister bottom, the side forces are balanced. For all practical purposes the soil force then consists of a single resultant which may be divided into vertical and longitudinal components, V and L. These components are concurrent; that is, they intersect. Non-concurrent forces or couples do not exist and the weight and pull are in the same plane as the soil force. The situation is different with plows and disks. There is no assurance that the longitudinal, vertical, and side soil forces are concurrent. If, as is generally the case, the components are non-current, a rotational tendency exists and the components cannot be combined into a single resultant force. We can deal with this situation in two ways. One way is to combine the system into two forces, one acting perpendicularly to the plane of the other but located to one side of it. The other way is to combine the three components into a single resultant plus a couple. (For methods of handling non-concurrent forces see any textbook of mechanics). When the soil force includes a couple, it can only be balanced by an opposing force and couple. In other words, the weight, the pull, and any parasitic soil forces must be so located that they produce the required opposing couple in addition to the main opposing force.

METHODS AND APPARATUS

Two methods for measuring and locating the line of action of the useful soil force are being used. These are, first, the pulling method, and, second, the method using the tillage meter. These will be described in turn.

In the pulling method shown in Fig. 1, the tool is pulled by a cable, chain, or link of some length. The position and angle of the pulling force is changed until the tool operates at the desired depth, width, and angle. The pull is then measured and its line of action located vertically and horizontally; the position of the center of gravity is found and the pull and weight are combined to obtain the soil force. This method is applicable to tools which will operate rather steadily with practically no parasitic forces. Reasonably steady operation, for example, can be obtained with a group of cultivator shovels or a gang of disks with no supporting or parasitic forces. With plows it is difficult to find both the vertical and horizontal position of pull which will eliminate bottom or landside friction and still keep uniform depth and width. The accuracy of the pulling method is strongly dependent on how closely the position of the pull can be determined while the tool is in operation. This is an inherent difficulty of this method because the forces, their positions, and the depth may vary from instant to instant. The weight is the only constant factor involved. Various means can be used to get average positions and angles. In Fig. 1 the string trailing from the disk operates on a protractor for obtaining the disk angle. The angle of pull is measured several times when the outfit is stopped. A string attached at the tractor clevis and held over the disk helps locate the pull with reference to the disk center.

The principle of the tillage meter is that the soil force is balanced by several forces located elsewhere. It is similar to one of the methods used for measuring forces on airplanes[2]. In general six forces must be measured and combined into a resultant, including a couple if any. Three forces, however, are enough for symmetrical tools having forces in only one plane. The points of measurement may be at any convenient place, but for the sake of accuracy it is desirable that points for measuring in one direction be spaced some distance apart. In our tillage meter the tool is attached to a triangular subframe which is held in a main or reference frame by six hydraulic dynamometers (See Figs. 2 and 3). Three support the subframe, two push it forward, and one holds it sideways. The three supporting units carry the weight of the tool and subframe as well as any vertical soil force. The latter is therefore the difference between readings in operation and readings when idle. A plow or disk moving soil to the right tends to lift the left rear corner of the subframe. We therefore put enough weight at that place so that the dynamometer is always subject to a downward force.

So far we have used five diafram type dynamometers and one sylphon bellows. The reason for applying the load

[2]Report No. 459, National Advisory Committee for Aeronautics, Washington, D. C., 1933.

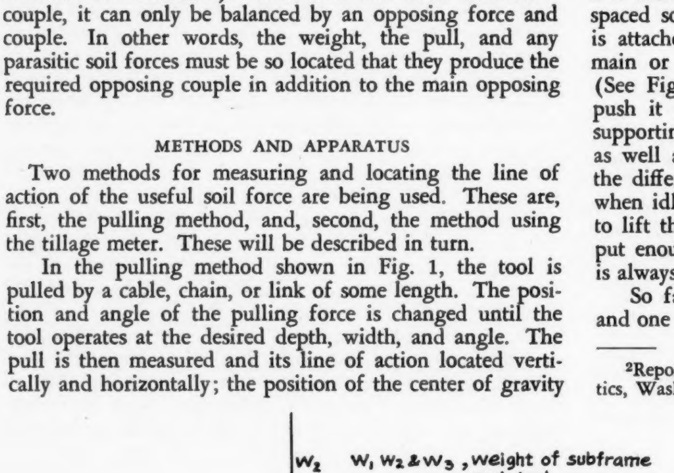


Fig. 3a.

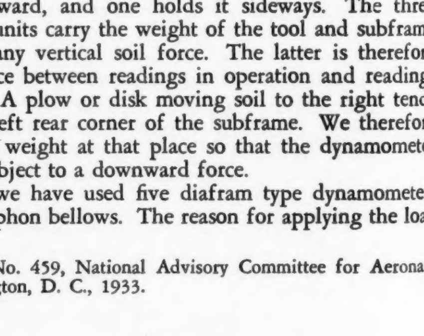


Fig. 3b.

FIG. 3 (A) FORCES ON THE SUBFRAME AND TOOL. (B) CROSS SECTION OF A HYDRAULIC DYNAMOMETER. A NEEDLE VALVE IN THE PRESSURE LINE IS USED TO DAMPEN FLUCTUATIONS OF PRESSURE

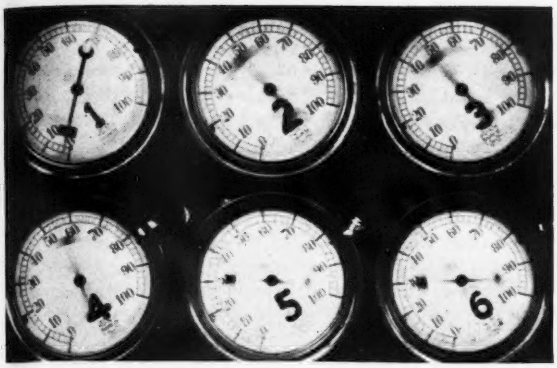


FIG. 4 SAMPLE GAUGE RECORD. THIS WAS A 10 TO 12-SECOND EXPOSURE. THE SIDE GAUGE, NO. 1, WAS INACTIVE BECAUSE SIDE SOIL FORCES WERE BALANCED

through ball bearings is to permit a small amount of free side motion. Testing of the dynamometers showed that it is important that the diafram and plunger (or sylphon bellows) be operated in the same range of displacement as when calibrated. This is because the elastic force of the diafram and its effective area varies somewhat with its displacement, the variation being proportionally greatest for a small diameter. To compensate for volume changes of oil due to temperature or leakage, provision is made to add oil with a pressure gun or remove part of it by an ordinary tire valve. The three vertical dynamometers can be checked by knowing the weight carried by each and the others are checked by applying a known force to them frequently.

Ultimately we expect to have a pressure-recording device, but so far we have been using photographic means to get simultaneous readings of six indicating gauges. The gauges are grouped together and a camera is focused on them. To get an average reading over some distance rather than an instantaneous reading, we shade the gauges, stop down the camera, and use process film. This permits an exposure of 10 seconds or more. The gauge pointers vibrate considerably but an average reading can be taken from the photo if excessive vibrations are dampened by a valve at each gauge. Fig. 4 shows a photo when cultivator shovels were being tested and the side force gauge, No. 1, was inactive. Ordinarily readings are taken directly from the films by viewing them over a lamp. This method has been fairly satisfactory, but has the drawback that a record is not assured nor available until the film is developed.

The ideal arrangement of the tillage meter would be to carry it on smooth steel rails so that the main frame or reference plane would have no motion other than straight forward. Carrying it on the ground introduces forces due to movements of the reference plane, though pneumatic tires help dampen such unwanted forces. The present mounting was chosen because of lower cost and for ease of moving from one place to another. Fig. 2 shows the mounting for tools other than plows. For plows the rear axle is relocated and an inclined wheel placed in the furrow.

RESULTS OF TESTS

Tests have thus far been made on tools as listed below; all tools had cutting edges in good condition except as noted.

TOOL	METHOD
Spring-tooth harrow, 8 teeth	Pulling
2-in cultivator shovels, gang of 7	Tillage meter
Oliver 16-in NC23 plow, with and without rolling coulter	" "
IHC 16-in HA1 plow, with coulter	" "
Deere 14-in No. 1441 plow, with and without rolling coulter	" "
IHC 14-in MBB plow with rolling coulter, sharp and dull shares	" "
15-in rolling coulter, well-oiled plain bearing	" "
18-in disk harrow, gang of 8 disks	Pulling and tillage meter

Time has not yet permitted a complete analysis of all tests. A few results and indications which we believe significant can be given, however, subject to more complete treatment later.

Cultivator Shovels. The testing of cultivator shovels is rather easy since only vertical and longitudinal forces are involved. Fig 5 shows results secured with sharp 2-inch shovels set at the angle shown. A gang of seven shovels was used at depths from about 1½ to 5 inches. The soil was heavy Hagerstown silt loam with moisture and apparent specific gravity shown. This might be classed as moderately firm. The shallower depth would be similar to the cultivation of row crops and the greater depth similar to work done with a field cultivator. The average *L* component of soil resistance was from 21 to 115 pounds per shovel, and in most of the tests the *V* component was about 19 per cent of the horizontal. As the shovels wear to a rounding edge, it would be expected that the vertical component would reduce and finally become an upward force. It should be remembered that figures given above are *average* forces. There is evidence that the momentary maximum on a single shovel may often be twice the average, and in clay loam the average would no doubt be higher.

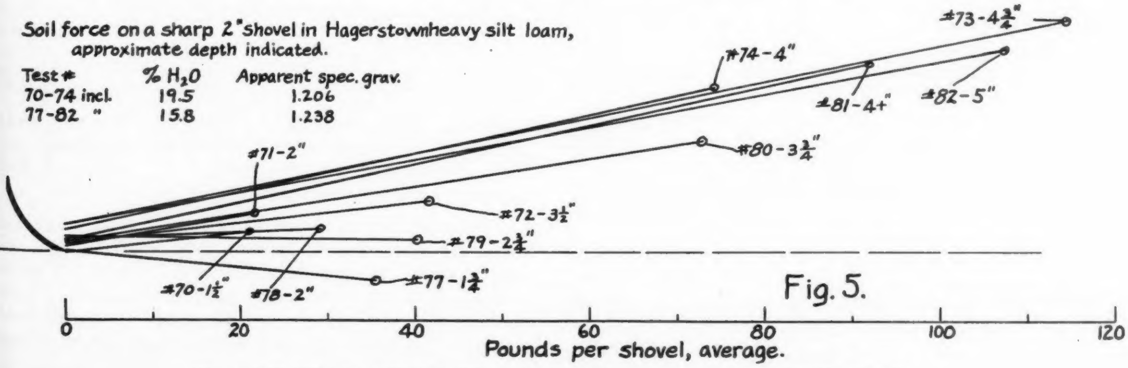


FIG. 5 SIDE VIEW OF AVERAGE USEFUL SOIL FORCES ON A 2-INCH CULTIVATOR SHOVEL

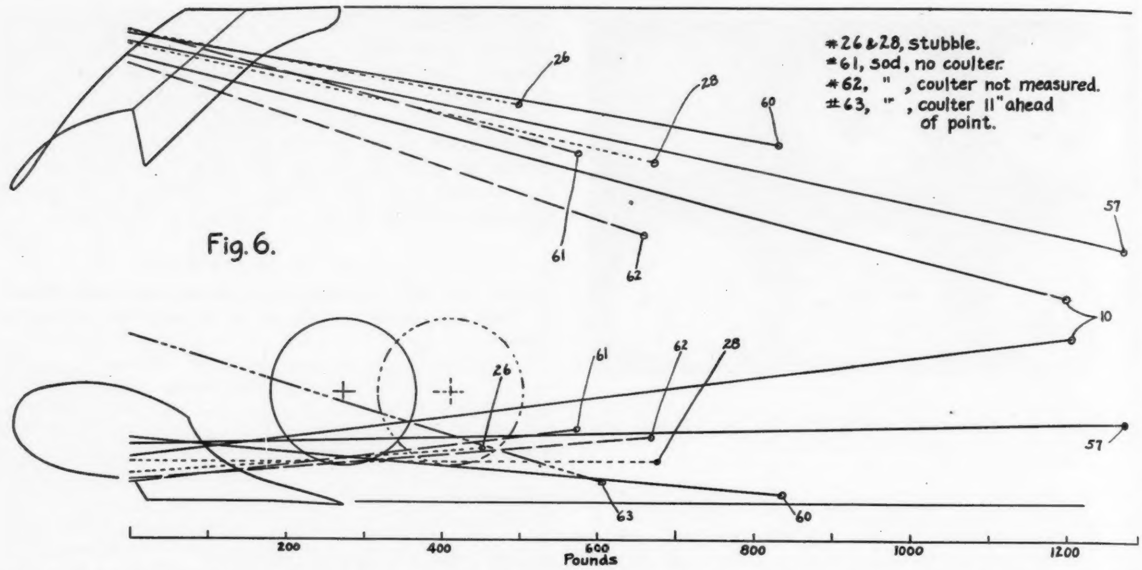


FIG. 6 LOCATION OF USEFUL SOIL FORCE ON A 16-INCH GENERAL-PURPOSE PLOW UNDER CONDITIONS RANGING FROM EASY TO DIFFICULT. A ROLLING COULTER SET DIRECTLY OVER THE POINT WAS INCLUDED, EXCEPT AS NOTED. COUPLES USUALLY PRESENT ARE NOT INDICATED. A NUMBER OF OTHER TESTS WERE WITHIN THE LIMITS SHOWN

Further tests are planned under other conditions of soil and shovel angle.

Plows and Rolling Coulters. Sixty-eight tests have been made so far on four general-purpose plow bottoms and rolling coulters under soil conditions from rather easy stubble to tough clay sod. Most of the tests were made with a rolling coulter. If the tests were repeated, we would distinguish at once between the plow and the rolling coulter because the two are entirely different. The soil force on a sharp plow is mainly backward, with smaller downward and side components, while on the rolling coulter it is upward with a smaller backward component. The result from the combination is therefore affected considerably by the resistance to penetration of the coulter.

Fig. 6 shows a few representative tests on an Oliver 16-inch NC23 bottom with the share in good condition. Only the main soil force is shown, the couples usually present not being indicated. Unless otherwise noted, the combination of plow and rolling coulter was tested, the coulter being set 3½ to 4 inches over the point. Test No. 57 was in clay loam sod—13 per cent moisture, 8⅛ inches deep, and a little over 16 inches wide. Test No. 10 was in silt loam sod—23.9 per cent moisture, 9⅜ inches deep, and 16½ inches wide. Other tests were under easier conditions of depth, width, or soil down to fairly easy stubble. Some of the differences in the location of the soil force in the horizontal plane are due to the width of cut being more or less than 16 inches, while others are as yet unexplained. The location and direction of the force in the vertical plane is of interest in connection with the rolling coulter. When testing the combination in moist soil, the force had a considerable downward component and met the plow surface about 3 inches above the furrow bottom. As the ground became drier, the force flattened out and finally took an upward slant, meeting the plow surface progressively higher. To study that effect tests were made on the coulter alone, and on the plow alone. The latter, No. 61 and No. 62, showed that the force on the plow alone was downward and that upward effects came from the coulter. The coulter alone sometimes required more than 500 pounds downward force to keep it 3½ inches deep in clay soil of about 10 per cent moisture, and in silt loam sod averaged more than 400 pounds. When, however, the coulter is set over the plow point, it does not require nearly as much force as when alone. A few tests in hard sod indicate an upward soil force of 130 to 200 pounds on the coulter in this position. Test No. 63 was with the coulter 11 inches ahead of the point in rather hard ground and shows how the large upward force on the coulter has a big effect on the force on the combination. The tendency is illustrated more clearly by Fig. 7. One practical use of this fact is in hitching. For example, a pulling force best for tests No. 61 and No. 62 might be wrong for conditions in No. 60 or No 63. In general, when a rolling coulter is used, the pulling force should be raised as the resistance to coulter penetration increases.

It has been mentioned that the soil force on a plow often includes a couple in addition to a resultant force. On the plow alone (right hand) this couple seems always to be counterclockwise when viewed from the rear. The rolling coulter adds an upward force, the effect of which is to reduce this couple or reverse its direction. In the following results the greatest clockwise couples occur when the soil is dry and hard; with more moist soil and a coulter the couple may be zero or very small:

Plow bottom	Couple value, ft-lb	Direction of couple as seen from rear
Oliver 16-in NC23 no coulter	40 to 50	counter clockwise
Oliver 16-in NC23 with coulter	43 or less	clockwise
Deere 14-in No. 1441 no coulter	80 +	counter clockwise
Deere 14-in No. 1441 with coulter	82 or less	clockwise

Three tests in moist sod with sharp and moderately dull shares on IHC (MBB) bottom gave practically no difference in *L*, but the dull shares reduced *V* about 125 pounds, making it almost zero. Extremely dull shares, a rolling coulter, and hard ground would result in a considerable upward value of *V* with the problem of getting penetration.

Disk Harrows. A gang of eight 18-inch disks has been

tried in the tillage meter, but for several reasons the pulling method has been more satisfactory with this tool. Fig. 1 shows the low frame made for it with provision for an adjustable hitch point, for shifting the center of gravity to obtain equal penetration of the disks and for adding weight as desired. The center of gravity was kept along the axle but moved as far toward the convex as necessary. Two significant things were observed, as follows:

1 The side force, *S*, was nearly always as much or more than the longitudinal force, *L*. This is proved by the fact that at disk angles of 15 to 24 degrees the angle of pull ϕ was usually 45 degrees or more. This is worthy of attention from the standpoint of designing bearings and bearing supports where they carry the side force, also in the design of offset disk harrows.

2 The soil force invariably included a couple. This was proved by the fact that the line of pull was behind and to the right of the center of gravity. The soil force balances the weight and the pull; therefore, it must include a couple.

Fig. 8 gives results for three weights on moderately firm silt loam, 14 per cent moisture, and apparent specific gravity of 1.222. The 300-pound weight represents the usual weight of such a disk with nothing added to increase it. The relation of weight, pull, and soil force varies with the hardness of the soil and the angle of the disk; the pull and soil force increasing for a given weight as the penetration increases. In Fig. 8 the *S* and *L* components of the soil force are considered as concurrent, and *V* is placed in a left-forward position to give the required moment. This arrangement can be converted into a single force plus a couple if desired.

Although the disk tests have not yet covered a great variety of soil conditions, we already see practical use for the results. One use is in the design of bearings for end thrust and of their supports for rigidity. When the side force is carried by the frame, it is doubtful whether the bearing supports are usually rigid enough sideways to prevent considerable deflection and cocking of the bearing. Under a pull of nearly 1,000 pounds, the total end thrust load on the three bearings was 850 to 900 pounds and the radial load 550 to 575 pounds. The radial load particularly is usually divided unequally among the three bearings, but the load on each can be approximated. Another use is in the design of offset disk harrows to reduce trouble now experienced with unequal penetration and wear of disks. If the center of gravity of each gang is not at the proper place (between the convex end and the center), the frames of these harrows are under torsion. The author suspects that these frames are like many other frames in being quite flexible under torsional loads. The sensible way to meet the difficulty appears to be to put the center of gravity of each gang at the best place, and to arrange it if possible so that the user cannot easily add weight except at the proper places. Frames can also be stiffened, but obviously the frame does not need much torsional stiffness if the weight on each gang is always in exactly the right place.

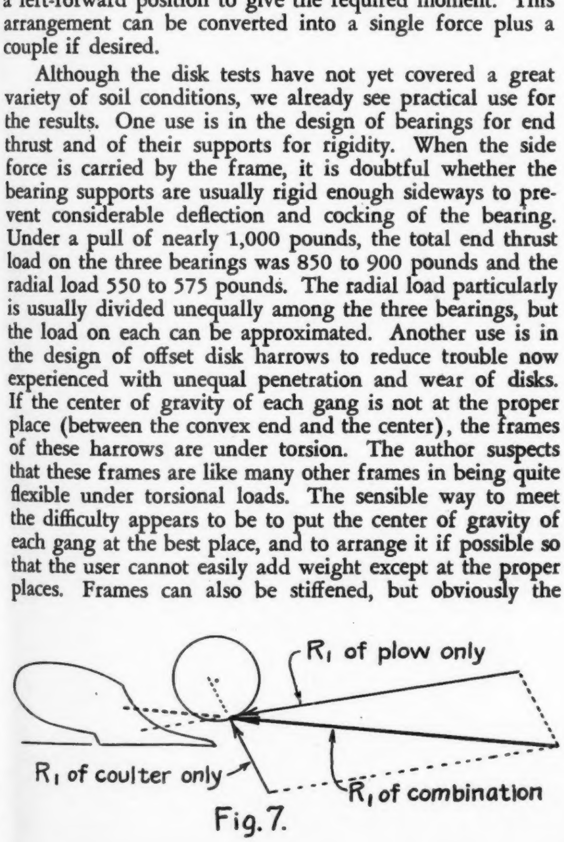


FIG. 7 SHOWING HOW THE SOIL FORCE ON THE ROLLING COULTER INFLUENCES SOIL FORCE ON THE COMBINED PLOW AND COULTER

CONCLUSIONS

1 Knowledge of the position, direction, and magnitude of the useful soil force on a tillage tool under conditions varying from easy to hard is important, because it is a large part of the total soil reaction on the complete implement. The latter balances the other forces, the most important of which are the pulling force and the weight.

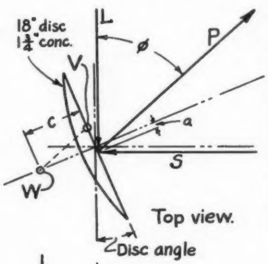
2 Such knowledge is useful as an aid to judgment in designing for strength, for applying the pulling force to the best advantage, and for selecting the best shape of tool for a certain kind or degree of tillage.

3 Two methods, the pulling method and the tillage meter method, are explained with some mention of important details in their use in locating and measuring soil forces.

4 For sharp chisel-shaped tools, such as cultivator shovels and plows without rolling coulters, the useful soil force usually has a considerable downward component. Actual values and locations found under some conditions are given. When a rolling coulter is added to a plow, it reduces or reverses the vertical component, the amount of change depending on the hardness of the soil and the position of the coulter. The soil resistance may or may not include a couple, the amount and direction of which is affected chiefly by the rolling coulter.

5 The soil force on a 18-inch disk as used in disk harrows is usually as much or more than the longitudinal force. It apparently always includes a couple. Values and locations of the forces given can be used to check designs with respect to bearings, frames, and weight distribution, as well as for hitching.

AUTHOR'S ACKNOWLEDGMENT: Credit is due Professor K. J. DeJuhasz, of the Pennsylvania Engineering Experiment Station for advice on apparatus used in this study.



For one 8-18" gang.

Weight, lb., W	300	410	535
Depth, inches	2	3-	4
Disc angle, deg.	22½	20½	22½
Pull angle, " ϕ	48	46½	44
Pull, lb., P	450	765	925
a, inches, approx.	¾	0	2½
b, " "	2½	1½	¾
c, " "	6¾	7+	8
d, " "	5-	4	5+
Side force, lb., S	335	555	641
Longitudinal " " L	300	526	667

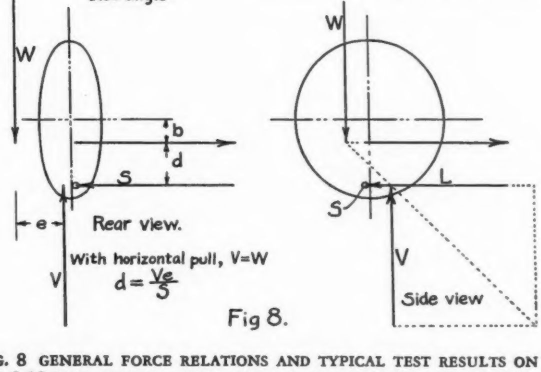


FIG. 8 GENERAL FORCE RELATIONS AND TYPICAL TEST RESULTS ON AN 8-18-INCH DISK HARROW GANG. IN THE DRAWING THE GANG IS REPRESENTED BY ONE DISK PLACED AT THE CENTER OF THE GANG. IF W IS MOVED AHEAD OF THE AXLE OR BEHIND IT, THE PULLING FORCE MUST BE LOWERED OR RAISED TO MAINTAIN EQUILIBRIUM

An Agricultural Engineer Faces the "Farm Problem"

By L. F. Livingston

PRESIDENT, AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

DURING the past few years the American farmer has become of greater interest to more people than at any time in our history. A large part of the effort and expenditure by government is in the farmer's behalf. Business finds itself faced with processing taxes, the public with rising food prices, the farmer himself with strange codes and restrictions on his crops. And while the Supreme Court sits in judgment over it all, part of our population cheers while another groans. There is no one in the land today who is not touched in some manner by the "farm problem," and apparently no one who does not deem himself eminently fitted to discuss it.

As one voice in this national debate, speaking in the name of several hundred agricultural engineers, it seems to me pertinent to point out that the term "farm problem" is a misnomer. We have 6,300,000 farms in America. That means we have 6,300,000 specific farm problems; no two farms and no two farm problems are alike.

In general, we have two classes of farmers—those who are successful and those who are not. The first class happens, unfortunately, to be the smaller of the two, operating only 35 per cent of the farm units. However, this class produces 80 per cent of the total farm income, or, in good times, about 8 billion dollars annually. This is the aristocracy of American agriculture.

But let not this description be misleading. Study of the successful American farm proves conclusively that great size and large investment are not requisites to fair income. Indeed, all too frequently they are liabilities. The successful farm may be as small as 25 acres, and often is. Usually it is a "family farm" to which father, mother, sons, and daughters contribute the bulk of the labor. Their past, their present, and their future are in the soil of that farm. And it is the family's boast that the farm pays.

Roughly, this 35 per cent that receives 80 per cent of the farm income numbers about 10,500,000 men, women, and children. Even during 1935 their income per person, regardless of age or sex, averaged better than $500, in addition to which their well-managed farms supplied them abundantly with shelter and food. It is hardly necessary to add that this class of farmers would resent mightily being regarded as pauperized or as constituting a national economic menace. I know these people. They are proud of their independence. With them industry and thrift are primary virtues. For one, I refuse to regard them as any part or parcel of what we mistakenly style the "farm problem." They have their individual problems, certainly, but they have the stamina and brains to overcome them standing squarely on their own feet. They have been the backbone of American agriculture in the past; they are its hope for the future.

The sore spot in our agricultural system is the fact that 65 per cent of our farmers receive only 20 per cent of the farm income. In terms of 1935 income, this was only about $70 each for some 19,500,000 persons. Of course, the majority had food and some sort of shelter in addition, but, astonishing as it may seem, a substantial number, probably one million in all, had to apply for public relief. It seems unbelievable at a time when the farm capacity is so large the government is paying farmers to plow under crops, that as many as one million of the farm population are public charges. However, such is the case. The country as well as the city has its slums, its shiftless and incompetent, its physically unfit, and its chronically unfortunate.

Taking a closer look at this very large class of farmers who generally are unsuccessful, we find that most of them are operating their farm plants under almost primitive conditions. What machinery they have is either heavily mortgaged or old, rusty, and inefficient. Their buildings lack paint and repairs. Their fields are run down, poorly drained, badly fenced. Their orchards are insect-infested, and they suffer tremendous losses annually from weeds, pests, and poor or diseased seed, to say nothing of lice-infested poultry and mongrel livestock. The vast majority must carry water from wells or springs, take their baths out of buckets, wash their clothing in the open or in unheated sheds, and use only oil lamps for light. In fact, no less than three million farm dwellers in America still depend on candles.

By no means do I wish to imply that lack of ability or effort is always responsible for poor conditions. Some of the hardest-working men are the worst off. Insufficient capital, ill health, or natural and economic forces beyond the individual's control may down the best of men. But whatever the reasons, here is a state of affairs that cannot be ignored. No less than one-half of our farms, to put it conservatively, are so unimproved or so down-at-the-heel as to be utterly unsuited to the demands of modern agriculture. They simply cannot compete with well-managed, up-to-date farm units. They are foredoomed to fail unless radically changed, regardless of whether crop prices are high or low. High prices will merely retard the rate of their failure.

In addition to the broad classes of successful and unsuccessful farmers, we have an infinite number of subclassifications based on crops, geographical location, types of soil, kind of markets served, and what not. We have one-crop farmers and diversified-crop farmers, poultry men and cattle ranchers, fruit growers and bee keepers. Two adjoining farms, one on high ground and the other on low, have distinctly different requirements and possibilities.

All of this, of course, is perfectly obvious and elemental, but it seems to have escaped the public and most of our political farm experts. As long as I can remember, there has been some sort of a "farm problem" being ballyhooed from the soap boxes, and it always has been in the singular, relegating all farmers like peas to a common pod. The result is that most of our so-called farm legislation has been predicated on the fallacy that all farmers are broke and in dire need. We have been legislating for the unsuccessful.

I do not say that all of this legislation has been bad. The efficacy or constitutionality of the AAA and other alphabetical agencies is beside the point. But I do say that

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Delivered at the State College of Washington, Pullman, January 7, before a group of agricultural engineers from Idaho and Washington, and before a similar group at Oregon State College, Corvallis, January 8.

in the clamor and confusion which has been raised by doctor, lawyer, baker, and candlestick maker in efforts to legislate the farmer into an agricultural Utopia, we have lost sight of a fundamental fact—that laws even such as a Solomon might write cannot make a poor farm into a good one or an ignorant farmer into a smart one. The American farmer's economic security must be won or lost, not at Washington, but on the acres of his own farm.

No matter what measures may be instituted for crop control, they won't delouse poultry and make good apples grow on unkempt trees. The argument is that, if the farmer has money to spend, he will revive his worn acres, get rid of his pests, stock blooded cattle, and replace his rusted machines with new—in other words, that lack of money alone is responsible for his farm's low estate. Some of the worst farm failures of which I know have been made by men with millions to spend. Indeed, farming as a means to show losses on income tax returns was most popular in the booming days before 1930 when farm prices soared.

Spending money alone on poor farms won't make them good. The test is of how and by whom the money is spent. If the farmer knows his business or has competent advice, he will spend wisely and to his profit. However, the difficulty here is that the farmer who knows his business is rarely to be found on a poor farm, also that farmers who don't know their business are rarely willing to be advised.

It is time that we spoke plainly about the chronically unsuccessful who need help with every ill wind that blows. As long as we gloss over their faults to win votes, we won't get anywhere—nor will they—and the distress signals will be flying from half the barns of the land with every depression. Farms that are intelligently worked don't wear out in five years, which has been the length of this depression. Machinery that is given ordinary care doesn't rust any faster in bad times than in good, weeds don't grow any faster, and it take no more effort to clean a chicken coop or cow stable whether wheat prices are high or low. Depression may be responsible for unpaid taxes and past-due interest on mortgages, but it can't be charged with boulder-strewn fields, leaky barn roofs, and plows that stand all winter in the furrow.

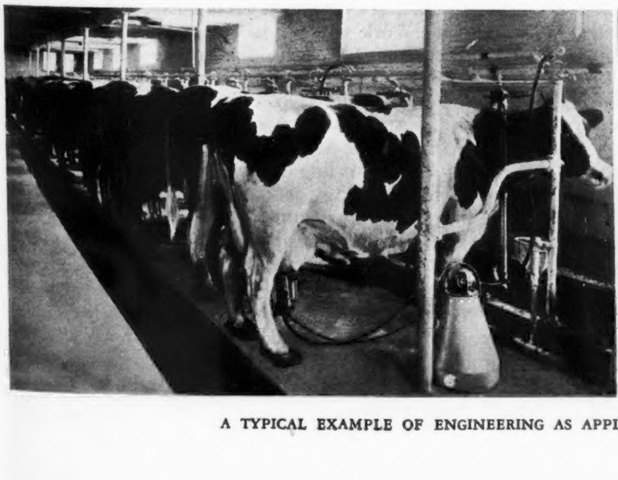
All of us can remember $2.00 wheat and 25-cent cotton. During the war our harvests were golden, and the years following up to 1930 were not entirely poverty-stricken for the farmer either. There *has* been farm money to spend in the quite recent past, but you know and I know that the nation is littered with farms, which, so far as physical improvement is concerned, have been steadily in depression and retrogression for fifty years.

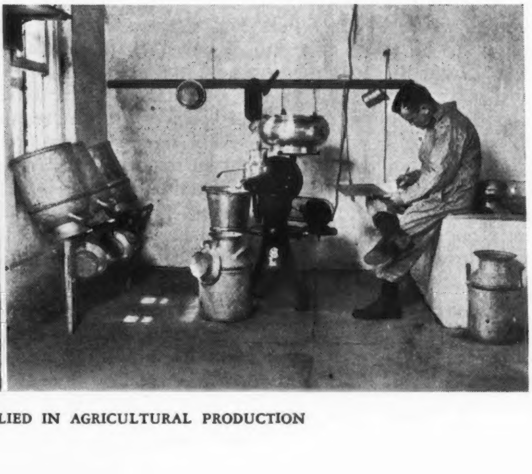
Farming is a business, an intricate business. It demands study, brains, experience, patience, sweat, and blood to make it a successful business. If we are going to make it a subject of federal subsidy to be supported out of taxes in season and out, it seems only reasonable and fair that we exercise some control over those who engage in farming, or at least over those who wish to be eligible for agricultural benefits out of the public purse. Plumbers, barbers, and truck drivers must be licensed. So must lawyers, doctors, preachers, and a host of others for whom the government assumes no responsibility, but taxes if they are successful to a modest degree. Then why not license the farmer? Let him furnish some evidence that he knows the fundamentals of farming and has some other qualifications for the job. As it is, a man who doesn't know a harrow from a cultivator, or whose farm plant is so obviously unfit that failure is a certainty before he turns a furrow or plants a seed, may elect himself an agriculturist and be assured that loud voices will be raised in the hustings when he doesn't make a go of it. The farmer so-called who is foredoomed to become a public charge is the sand in the cogs of the whole system. He should be classed apart, separately provided for if necessary, but agriculture as an institution should be relieved of his depressing influence.

Perhaps it is ridiculous even to suggest such a thing in the face of the so-called farmer vote. Just so long as a large part of our farm population is periodically in need of help, there will be political profit for those who promise it help. But the suggestion is no more ridiculous than our past and present systems of penalizing those who do for the benefit of those who don't, won't, or can't. The tax to keep the unsuccessful farmer successful, and to keep the unproductive farm in production, regardless of how this tax is applied or by what means it is collected or under what name it is called, falls eventually upon the successful farmer as surely as it does upon the successful business man. The worn acre competes with the fertile, the scrawny hog with the fat, the diseased tree with the healthy, and the market is flooded with inferior crops while thousands of good acres stand idle.

It seems to me to be neither unjust nor a hardship to insist that a man, who expects us to share with him his failure, should be at least primarily equipped for the task. Surely our economic system would not be seriously jolted, and it might be materially helped, if we frankly recognized that it takes more than land to make a farm and more than a pair of overalls and a hoe to make a farmer.

Facing the situation as it is, however, and as it no





A TYPICAL EXAMPLE OF ENGINEERING AS APPLIED IN AGRICULTURAL PRODUCTION

doubt will continue to be for some time, what can be done about it? Discussion should be a prelude to constructive action.

There is much that can be done, and the research man and the agricultural engineer—not the politician—should form the spearhead of the action. Big things are ahead for agriculture despite the presence of rotten and scrub apples in the barrel, if we can get rid of the bad apples before the good ones are spoiled.

First of all, some of us should change our viewpoints. A few of the needs of agriculture may be alleviated by intelligent legislative control, but by and large the salvation of the farmer is to be worked out in one spot and by one person—the farmer himself on his own farm. In this stupendous task involving 6,300,000 farm units, all that the combined agricultural agencies of the nation can do is to *help the farmer to help himself*.

Also we must stop putting emphasis on price as the major factor governing farm net income, and instead put our emphasis on quality and cost. A vast industrial market awaits a wide range of agricultural products, old and new, providing that the cost of these products as raw materials is not prohibitive. There has never been an overproduction of food, but underconsumption of food because of the consumers' inability to buy at existing prices is a condition that has existed in good times and in bad. In 1929, three-fourths of the non-farm population in rich America lacked the means to provide itself with an adequate diet at minimum cost. Ninety per cent couldn't afford a liberal diet. In other words, the bulk of the farmer's customers couldn't buy what they needed, because food cost too much, but depression had nothing to do with that condition.

Production and marketing costs alike can be lowered. The grower's margin of profit can be widened. To say that agriculture, even as we know it at its finest today, has reached the peak of its efficiency is an ostrich-like, head-in-the-sand viewpoint. A cooperative study made by the USDA Bureau of Agricultural Engineering of more than one hundred better farms in various parts of the country revealed that every one of them could be improved in the light of existing knowledge, and, to an appreciable extent, at a cost within the present means of the owners. In many, the intelligent expenditure of a few hundred dollars was sufficient to turn losses into profits.

Agriculture is our oldest industry. That is at once its pride and its greatest handicap. Despite modern machinery, improved low-cost fertilizers, striking advances in agricultural explosives, new and more effective means for pest control and increased scientific knowledge generally, we have let our farming practices become burdened by tradition to which we are blind. Fields laid out by our grandfathers, who knew only animal power, stand just as they were originally though we are now in a gasoline age. Barns and outbuildings built by the same hands are still doing service in the same old way. Millions of dollars are added to farming costs annually by such a simple waste as plowing around boulders, that might be removed in spare time at a cost of a few pounds of dynamite. And these wastes are not exceptional, they are general. There is not one farm in a hundred that is not in need of some improvement. Farm losses each year, due to wastes and other controllable inroads, equal and probably exceed the farm income.

Here is a tremendous job for the agricultural engineer. His is the responsibility of translating into practice the discoveries of our scientists, the inventions of our mechanics, and all the day-to-day agricultural advances. The number of engineers available for this task is a pitiful handful in view of the need. We have merely a regiment of men faced with the job of leading the advance in the rebuilding of an empire. What we need is an engineer in every county seat, and he should be a general practitioner in farm ills—the economic country doctor. County agents are doing a wonderful job, but, however active and well trained, they cannot begin to do the work alone. It is as preposterous as to ask one lawyer to handle all the civil needs of farmers, or one physician to prescribe for all their aches and pains.

The tendency in the past has been to specialize in certain phases of farm operation. The specialist is still vitally needed, but the trouble is that a farmer can't afford to call in a whole corporal's guard of experts to determine what is best for him to do. He receives free some general treatment of his agricultural ills from the agricultural extension service, and this is largely responsible for the past progress made in agriculture, but what he now needs, in addition, is an engineering diagnosis and treatment for his common engineering difficulties. Then, in more acute or puzzling problems, the specialist could be called in exactly as is now done in medicine and law.

Youth is asking for opportunity. No field today promises more than this one. However, if the field is big, so are its requirements. The general agricultural engineer will have to know more about farming than his potential clients. He will be judged solely by the results he achieves as they are set down in cold figures of profit and loss. And besides being a good general engineer, he will have to be a supersalesman of progress—some farmers will literally have to be blasted into taking action for their own good. But if he is all of these things, he will be able to make a good living. More than that, he will be able to point the way to economic security in agriculture for all time.

We need more good farm cooperatives that will not only steer the farmer's course in marketing, but will also blaze a broader trail for the movement to process farm crops on the farm. As industry reaches out more and more into the agricultural field for raw materials, the farmer should be ready to meet it with goods in semi-finished form. Group-owned processing plants are already filling a place in the farm picture. The movement is only in its infancy.

The rural press has its part to play. It should do more than herald the new. Every farmer worthy of the name should be a regular subscriber and earnest student of at least two publications—one, the best farm paper in his state, and, second, a good national agricultural magazine. This is a salesmanship job for the press. It is likewise a responsibility.

And, above all, every farm should have sound business management. Work such as is being done by the Cedar Valley Farm Business Association in Iowa, and similar organizations that are sprouting into life elsewhere, will save agriculture millions in the aggregate. The Cedar Valley group has a route man who visits each member farm at least quarterly. He audits the books, which means that accounts are kept according to a system. He discusses investment problems, plantings, marketings, and advises generally with the farmer on matters of business. Members get together at intervals in small groups and talk over their problems. Outlook letters are received weekly; trends are studied. Every farm is mapped and studied as an individual production unit, all at a cost of $15 per member per year.

Solve the individual farm's problem, and we solve the farm problems of the nation. It is with the farmer himself, on his own broad acres, that we who would improve the situation must work.

New Developments in Mechanical Equipment to Control Insect Pests and Plant Diseases

By R. M. Merrill

AGRICULTURAL ENGINEER, BUREAU OF AGRICULTURAL ENGINEERING, U. S. DEPARTMENT OF AGRICULTURE. MEM. ASAE

THE PURPOSE of this paper is to present very briefly some of the most recent developments in mechanical methods of pest control which should be of interest to agricultural engineers. The annual losses caused by different pests, an estimated two billion dollars by insect pests and one billion dollars by disease, and the cost of combating these pests make the pest control problem one of major economic importance. The problem of poisonous spray residues on orchard and garden products at harvest time has, in the last few years, intensified interest in methods of control that do not involve spraying, as well as materials for insecticides which are less objectionable. The tolerances that have been established, in most cases, make it very difficult to obtain control of pests with the present spraying materials without having an excess of poison on the fruit at harvest time, which must be removed by washing before the fruit is marketed.

When increased infestations of pests occur, together with the residue problem, it is necessary to use a combination of methods of control instead of depending on spraying alone. As an example, the codling moth infestation has increased in some areas to a point where, in addition to the long-accepted spraying program, it is necessary to supplement by banding trees, scraping trees, trapping moths, and clearing the orchard in general to keep the insect population down. The costs of combating a serious infestation of insects are shown by figures from the Troth-Burton orchards near Orleans, Indiana, covering the years 1926 to 1933. Mr. Troth states that the total average cost of raising a bushel of apples during this period was 77.75 cents, and that 39.6 cents of this amount, or 50.9 per cent, was directly chargeable to pest control. (Journal Econ. Ent., vol. 28, no. 4, pp. 698-701)

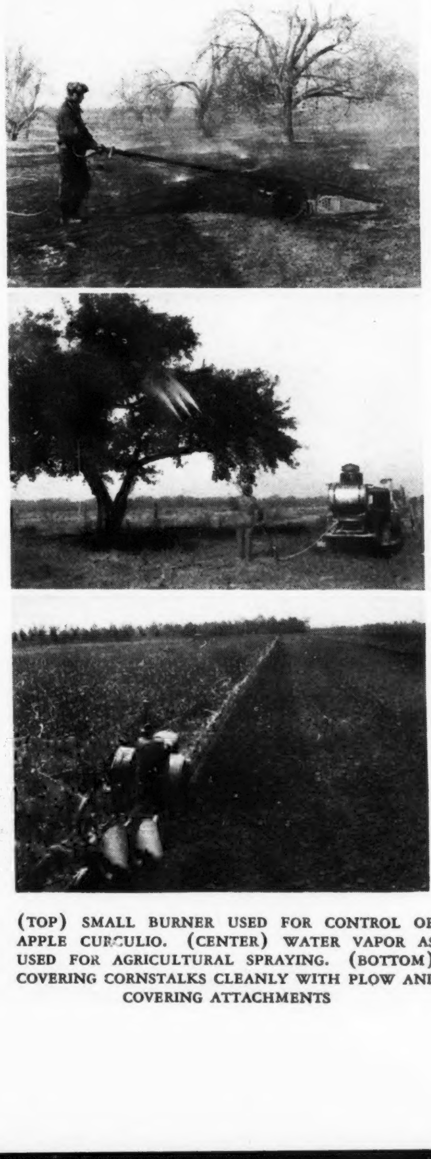
The pest control problem is being attacked at the present time by a great number of agencies, including entomologists, pathologists, chemists, horticulturists, and engineers employed by the federal government, by states, and by commercial organizations, but I will attempt to speak only of some of the work being carried on by the USDA Bureau of Agricultural Engineering.

Burning. Burning of infested plant material or of insect hibernation material has often been considered as a promising control method. In practice, however, it has been found difficult to obtain effective control without excessive cost. Even with a flame of approximately 1800 degrees Fahrenheit the length of exposure necessary to burn vegetation completely is considerable. In orchards near Troy, Kansas, the apple curculio was apparently controlled by burning trash under the trees, but in Ohio an attempt to control the apple-flea weevil, an insect with somewhat similar habits to the curculio, was not very effective.

Burning was also attempted as a control for the pea weevil near Moscow, Idaho. A strip of peas was planted at the borders of pea fields about two weeks earlier than the main crop. When this border strip of peas came into blossom, it attracted the pea weevil before the plants in the main field came into blossom. A tractor-mounted burner was then passed over this border crop in an attempt to kill the weevils which had congregated there. However, with the crawler tractor moving at its slowest speed, the exposure to the heat was not sufficient to kill all the weevils sheltered in the blossoms and leaves. A larger and more powerful burner may be more successful, but since preliminary tests indicated the practice of plowing under the trap crop to be effective, the burner trials have been dropped for the present at least.

Plowing. The practice of clean plowing continues to be considered an effective control for many pests and the development of equipment to secure better coverage has made considerable progress. Improvements have been made in plows by plow manufacturers and special attachments have been developed by state and federal agencies.

A disk jointer, which has been called a self-aligning disk jointer, has been developed by the Bureau of Agricultural Engineering, and is proving to be a valuable attachment by farmers *(Continued on page 16)*



(TOP) SMALL BURNER USED FOR CONTROL OF APPLE CURCULIO. (CENTER) WATER VAPOR AS USED FOR AGRICULTURAL SPRAYING. (BOTTOM) COVERING CORNSTALKS CLEANLY WITH PLOW AND COVERING ATTACHMENTS

Presented before the Power and Machinery Division of the American Society of Agricultural Engineers at Chicago December 1935.

A Low-Cost Floor of Reinforced Tile

By Henry Giese and C. T. Bridgman

RESEARCH ENGINEER AND RESEARCH FELLOW IN AGRICULTURAL ENGINEERING, IOWA STATE COLLEGE

AS A RESULT of cooperative research by the Iowa Agricultural Experiment Station and the Clay Products Institute of Des Moines, Iowa, relating to the improved use of clay products in farm-building construction, a new type of floor construction using a combination clay tile, concrete, and steel has been developed.

This floor as illustrated in Fig. 1 consists essentially of precast tile beams or joists with floor tile fillers or span tile extending from one beam to the next. The beam tile used in the experimental stages are illustrated in Fig. 2. In practice, the beam or joist is formed by laying the blocks end to end, with mortar between, in sufficient number to secure the proper length. This can be done on any flat surface such as a floor. In the two channels formed by the beam tile are placed reinforcing bars (Fig. 3) carefully imbedded in concrete.

The beams are allowed to cure until the concrete has attained sufficient strength for handling, after which the beams or joists are placed in a manner similar to wood joist construction. The beam weight being approximately 20 pounds per lineal foot, the beams can easily be handled by two men using, as handles, 1 by 2-inch wood pieces inserted in the openings in the end blocks. The floor tile fillers extending from one beam to the next are laid in a mortar bed on the ledge formed by the beam tile and with mortar placed between them. After the filler tile are in place, a concrete floor is cast over the entire unit.

Should other than a concrete floor be desired, any other surfacing material can be placed over it. If wood floors are desired, either sleepers or clips to hold sleepers are placed in the topping. Carpet, linoleum, or rubber tile can be laid on the concrete surface. Tile, terazzo, or colored concrete can be placed as the topping is being finished.

The weights and approximate cost of the floor are given in Table 1.

In order to secure information regarding the strength and other characteristics of this method of construction, a number of beams were made, cured, and tested. The beams

Presented before the Farm Structures Division of the American Society of Agricultural Engineers at Athens, Georgia, June 1935. Journal paper No. J 302 of the Iowa Agricultural Experiment Station, Project No. 433.

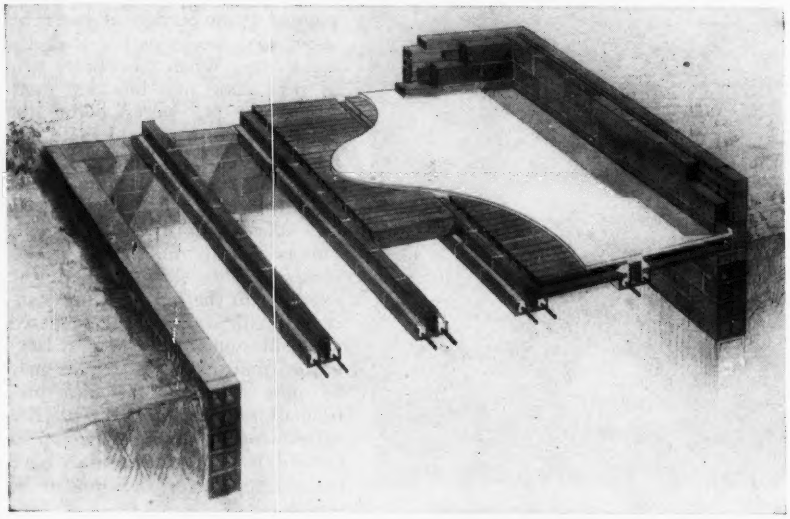
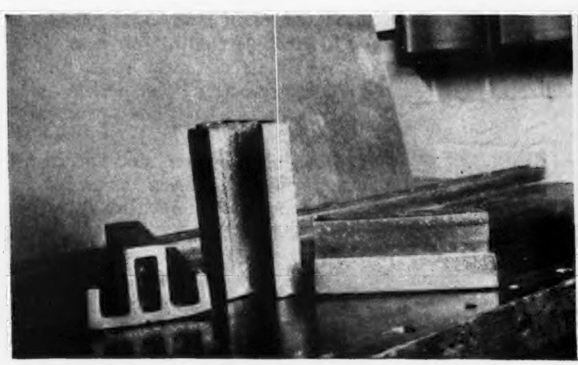
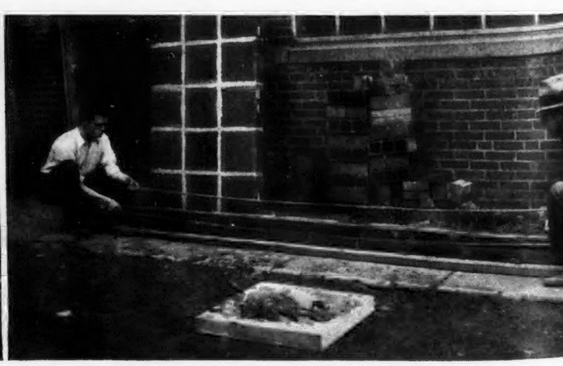


FIG. 1 (LEFT) THE NEW TYPE FLOOR CONSTRUCTION CONSISTS OF PRECAST TILE BEAMS OR JOISTS WITH FLOOR TILE FILLERS OR SPAN TILE EXTENDING FROM ONE BEAM TO THE NEXT. FIG. 2 (BELOW, LEFT) BEAM TILE USED IN THE EXPERIMENTAL STAGES. FIG. 3 (BELOW, RIGHT) PLACING REINFORCING BARS IN THE TWO CHANNELS FORMED BY THE BEAM TILE





(see Fig. 4) consisted of the beam section (A) alone, a floor section (B) using 3-inch filler tile with a total width of 28 inches, a floor section (C) using 4-inch filler tile with a total width of 16 inches, and a floor section (D) using 5-inch filler tile, and otherwise same as (C). Two ½-inch plain round bars were used for reinforcing all beams. The mortar used consisted of 1 part cement, 3 parts sand, and ⅓ part mortar mix. Beams were kept moist for seven days and cured 30 days before testing. In testing, the beams were freely supported at the ends. Loadings for bending were applied at the third points; and for shear, at two feet from the supports. Beams were tested to destruction.

Observations were made of the deflection of the beams under various loadings and by the use of a Berry strain gauge, of the deformation of the concrete in the surface and of the steel reinforcing bars. The load at failure and the deflection at the design load are given in Table 2.

Fig. 5 shows the live-load deflection performance of the sections. It is evident that the section possesses ample stiffness and that failure does not occur until material deformation has occurred.

The calculated stresses at failure obtained by using the usual formulas for reinforced concrete are given by Table 3. To facilitate the design of the floor for various conditions of span length and floor loading, Table 4 is provided.

While the original tile gave quite satisfactory results, certain changes are recommended. The depth of only 4.7 inches in the original was scarcely sufficient to carry loadings during the construction period before the span tile and concrete covering are placed. These latter provide the compressive strength necessary in the beam. The new tile is 6 inches in depth. A heavier compression web in the top and fillets to strengthen the corners have also been added. Scoring of the sides and top assure better bonding between

TABLE 1. WEIGHT AND COST OF TILE FLOOR

Beam spacing o.c., in	Length filler tile, in	Weight per square feet, lb 3-in filler	Weight per square feet, lb 4-in filler	Cost per square feet 3-in filler	Cost per square feet 4-in filler
16	12	44.1	47.0	$0.270	$0.284
20	16	40.9	43.3	0.242	0.256
24	20	38.5	40.7	0.224	0.235
28	24	37.0	39.0	0.211	0.222

TABLE 2. RESULTS OF FLOOR LOAD TESTS

Section	Span ft	Width of section, in	Load at failure (2-point load) lb	Ultimate load uniform lb	Ultimate load, lb per ft	Design load, lb per ft (factor, 4)	Deflection at design load, in
10-ft beam	9.5*	7.6	2225	2967	314	78.4	0.24
12-ft beam	11.5	7.6	1425	1900	165	41.3	0.21
14-ft beam	13.5	7.6	1240	1653	122	30.6	0.30
16-ft beam	15.5	7.6	1040	1387	90	22.4	0.41
10-ft beam 3-in tile	9.5	28.0	4353	5804	612	153.0	0.05
12-ft beam 3-in tile	11.5	28.0	3930	5240	455	113.7	0.10
14-ft beam 3-in tile	13.5	28.0	2640	3520	261	65.2	0.12
10-ft beam 4-in tile	9.5	16.0	4916	6555	690	172.5	0.05
14-ft beam 4-in tile	13.5	16.0	3500	4666	345	86.2	0.13
16-ft beam 4-in tile	15.5	16.0	4815** 2740	3653	236	59.0	0.19
16-ft beam 5-in tile	15.5	16.0	3555	4740	306	76.4	0.17

*Deformed bars used in this beam.
**Shear.

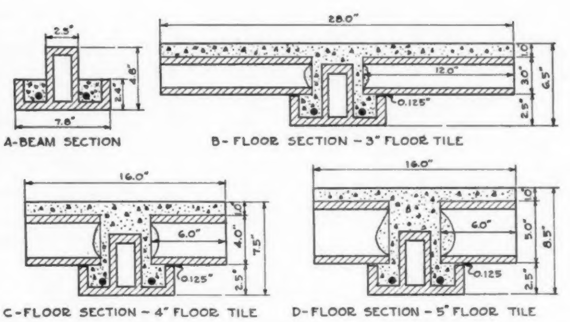


FIG. 4 DETAILS OF BEAM AND FLOOR SECTIONS USED IN TESTS

the concrete and the tile. Fig. 6 illustrates the new tile design together with a number of construction details. The floor can be readily adapted around stair wells and for carrying partitions not over load-bearing walls. It can be used for stair and roof construction. The beam is suitable for lintels over large openings such as garage doors.

Ceilings, or the under side of the floor, can be left the

TABLE 3. CALCULATED STRESSES AT MAXIMUM TOTAL LOAD SUPPORTED BY SECTIONS

Section	Dead load, lb	Total load, lb	Maximum total bending moment	Unit stress in steel, lb/sq in	Unit stress in compressive area, lb/sq in	Horizontal shear lb/sq in	Bond stress, lb/sq in
10-ft beam	200	3,167	47,380	34,685	8,550	460.0	161.5
12-ft beam	240	2,140	38,520	28,199	6,980	312.0	109.0
14-ft beam	280	1,933	40,593	29,594	7,290	281.5	87.5
16-ft beam	320	1,707	38,834	28,435	7,025	249.0	87.0
10-ft beam 3-in tile	820	6,624	99,360	50,591	2,180	165.8	211.0
12-ft beam 3-in tile	980	6,220	112,032	57,043	2,450	155.9	198.2
14-ft beam 3-in tile	1148	4,668	98,028	49,900	2,145	117.0	149.0
10-ft beam 4-in tile	620	7,175	107,625	46,671	2,305	139.7	200.0
14-ft beam 4-in tile	868	5,554	116,214	50,396	2,920	108.0	155.0
16-ft beam 4-in tile	992	4,645	111,480	48,343	2,380	90.25	129.5
16-ft beam 5-in tile	1065	5,805	139,320	52,633	2,805	88.00	139.0

TABLE 4. REINFORCING AND ALLOWABLE SPACING FOR BEAMS
(4-inch floor tile)

Beam length, ft	40 lb/sq ft live load	50 lb/sq ft live load	75 lb/sq ft live load	100 lb/sq ft live load
10	2½-in bars	2½-in bars	2½-in bars	2⅝-in bars
	28 in o. c.	28 in o. c.	28 in o. c.	28 in o. c.
12	2½-in bars	2½-in bars	2⅝-in bars	2⅝-in bars 20 in o. c.
	28 in o. c.	28 in o. c.	28 in o. c.	or Reinforced 12-100* 28 in o. c.
14	2½-in bars	2⅝-in bars	2⅝-in bars 16 in o. c.	Reinforced 14-100*
	28 in o. c.	28 in o. c.	or Reinforced 14-75*	24 in o. c.
16	2⅝-in bars	2⅝-in bars 20 in o. c.	Reinforced 16-75*	Reinforced 16-100*
	28 in o. c.	or Reinforced 16-50* 28 in o. c.	28 in o. c.	20 in o. c.

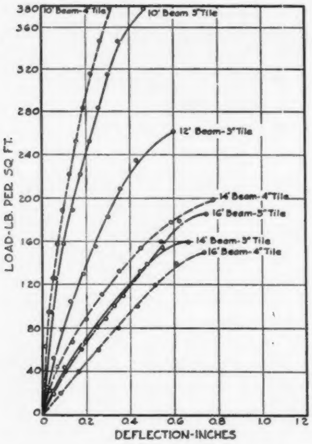
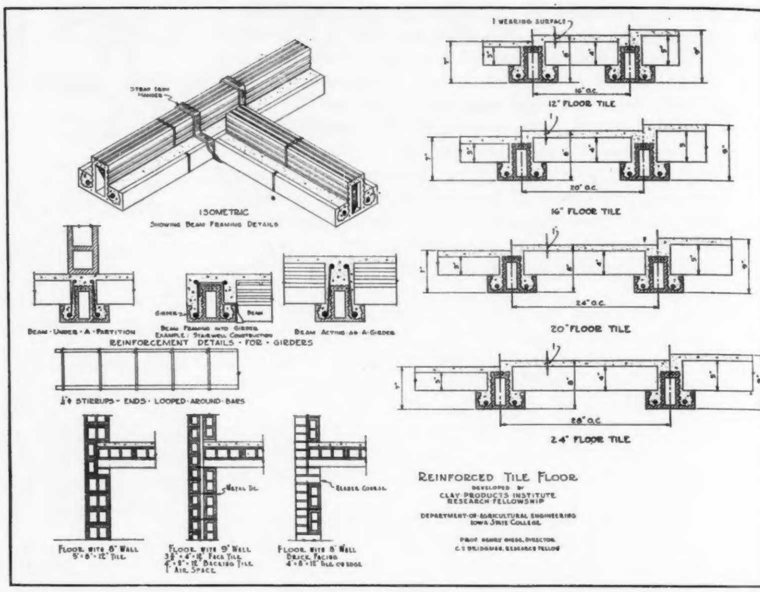


FIG. 5 (ABOVE) LIVE-LOAD DEFLECTION PERFORMANCE OF BEAM SECTIONS. FIG. 6 (RIGHT) NEW TILE DESIGN AND A NUMBER OF CONSTRUCTION DETAILS



natural color of the tile or may be decorated. The ceiling may be painted or stenciled to harmonize with various interior treatments. The proportions of the beam are well adapted to producing an attractive beamed ceiling effect. The appearance of a continuous beam may be obtained by coloring the mortar to match the tile. If a flat ceiling is desired, metal lath can be fastened to the beams by metal hangers.

The advantages of this type of construction may be summed up as follows:

1 The material used being non-combustible, it will not support fire and should offer a considerable of fire resistance.

2 Laboratory tests and experience on actual construction have shown it to have ample strength and stiffness for satisfactory construction.

3 The floor is easily constructed and with supervision there should be no question as to reliable performance.

4 The cost is low; experience on a number of jobs has compared favorably with the calculated costs.

5 The design is flexible to meet widely varying loading conditions. For light loads and short spans, 3-inch filler 24 inches long can be used. Increased strength can be obtained by either shortening the length or increasing the depth of the filler tile or both.

Mechanical Equipment to Control Insect Pests and Plant Diseases

(Continued from page 13)

who are using it. This disk jointer is designed to perform the functions of the conventional coulter and jointer but with fewer operating and adjustment troubles. One of the important features of the self-aligning disk jointer is the fact that the draft of a plow with this attachment is apparently from 10 to 15 per cent less than the draft of the same plow equipped with coulter and jointer.

Vapor Spraying. In studies of methods of economically applying concentrated insecticides and fungicides, some preliminary work with the use of water vapor has been carried on. This principle is not new, as steam has been used experimentally in the past for applying spray materials with apparently indifferent results. For the present tests vapor generating units which are in common use for cleaning buildings and machinery and for stripping paint are being tried. These generators produce a finely divided mist or fog which emerges from the nozzle with considerable force. A large volume of this finely divided vapor is produced from a small amount of liquid. One of the outfits used experimentally had a capacity of 5/8 gallon of water per minute and the larger unit a capacity of one gallon per minute. The spray produced at 100 to 150 pounds appears to compare very favorably in covering qualities with that produced by a hydraulic sprayer using several times as much water at 250 to 300 pounds pressure. Because of this economy of material it is felt that the method has considerable possibilities in the application of more concentrated and more expensive materials than are commonly used with the conventional hydraulic sprayer.

The vapor generator has been used in a preliminary way by the U. S. Department of Agriculture on pea vines at Madison, Wisconsin, on grapes at Sandusky, Ohio, and by Dr. Nixon at State College, Pa., on several different kinds of row crops and fruit trees. These preliminary tests have indicated that apparently the vapor has given as effective control of insects and diseases as could be expected from the regular hydraulic spray program and with only about one-fourth to one-eighth of the quantities of material. No definite data are available from these preliminary tests, but next season it is expected that formal tests in direct comparison with other methods of spraying now in use will be made.

Vapor spraying lends itself particularly well to row-crop spraying since the boom and nozzle problem is a simple one and the mist rolls through the foliage of a plant readily. The equipment is light in weight, which is especially advantageous when it is used on truck crops.

Although it is doubtful whether insoluble materials can be used through the heating coils of the vapor generator, it is a relatively simple matter to inject any material desired into the vapor after it leaves the coils. It is hoped that another season's tests will show whether the vapor method of spraying will be of economic value.

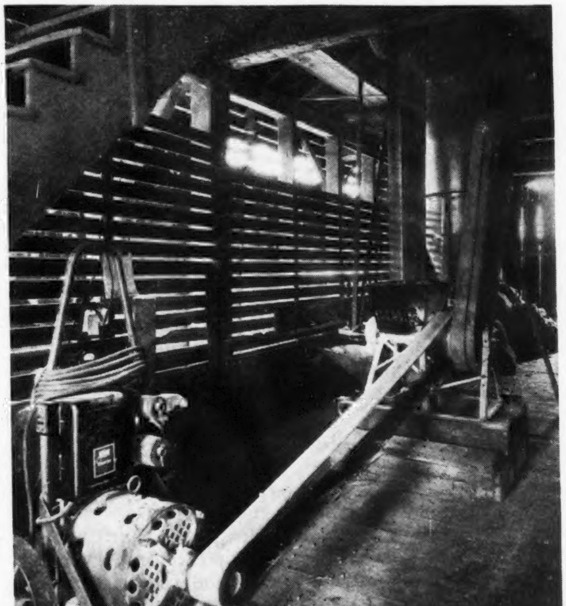
Farm Structures Planned for Electric Wiring and Appliances

By H. B. White

ASSISTANT PROFESSOR OF AGRICULTURAL ENGINEERING, UNIVERSITY OF MINNESOTA. MEM. ASAE

THE BUILDINGS of the pioneer were not very complicated and hence not difficult to plan. The log house plan required two lengths of logs, the long for the front and rear, the short for the two ends. The front door was usually in the middle of one side and the rear door in the middle of the other side. Windows were placed very regularly: two in front, one in each end, and one or two at the rear. There was a narrow crude stepladder at one end. One partition and one door completed the first floor, except that in some cases a trap door led to the hole beneath the floor. One window at each end, a partition and door made up the second floor details. The sod shanty of the prairie was smaller but similar in plan to the log house. On the prairie was developed one of the original general-purpose buildings of the farmstead. It stood north and south with doors to the east. The north end, if the plan was elaborate, sheltered the farm implements during the long winter and spring. Next came the horse stable, then the cow stable, and last the hen house. This structure was built with posts set in the ground in three rows. The middle taller row supported a ridge pole, the other two rows the plates. The entire structure was covered with small poles and limbs and then banked and roofed with straw or slough hay. This construction made a warm shelter but difficult to keep sanitary and in good repair.

In recent years the introduction of new building materials and new equipment has complicated the planning of farm structures until at present it is, and in the future will be, more of an architect's job to plan a farmhouse or a farm barn and have all the details arranged so that everything works to best advantage. The futility of planning a building without giving proper consideration to improved methods of doing the work in the building or the proper installation of labor-saving devices was well shown when in the early days of hay slings the barn builder, not knowing about slings, made the hay door much too small to admit the half load of hay that the farmer wished to take into his barn at one draft.



Presented before the Farm Structures and Rural Electric Divisions of the American Society of Agricultural Engineers at Chicago, December 2 to 4, 1935.

A review of the past helps us to realize the progress we have made in arriving at our present stage of development in farm structures planning. We need also to recognize that rural architecture has been receiving considerable attention the past few years, and that when construction work gets under way once more, there will be a keen appreciation of the many improvements that have been made and are waiting to be put to use. The higher standards in dairy barn and milk house sanitation, the better production from properly sheltered poultry, when eggs are high in price, and the better storage of farm crops and the great advance in the comforts and conveniences of the newly built farmhouses all show the quick acceptance of advanced methods and improved materials and equipment in farm homes, as well as elsewhere.

In trying to predict the future the architect and engineer is doing what he has been trained to do accurately and carefully. He must bring together all his knowledge of fundamentals and test out the new ideas, plans, methods, materials, and equipment in new combinations, and from them select those that will be strong, useful, and of good appearance. Strength, utility, and beauty are the graduations on his architectural gauge when he measures these new appliances and methods.

In planning farm structures for electric wiring and appliances the architect is bringing into his design the aid of two of the characteristics of good architecture, namely, utility and beauty. Surely light in a structure adds to its utility in the states where the long winter evenings may be so greatly improved by proper lighting. The power appliances make for utility of space in the buildings, and electricity certainly brings them to the farm as nothing else has ever done. Proper lighting improves the appearance of a well-kept room, building, or farmstead. A yard light on a farmstead, with two 3-way switches and one 4-way switch, is a simple but splendid example of adding beauty and utility to the farm home.

The introduction of electricity into the farm-build-

ing program has added interest as well as work to the field of the agricultural engineer who plans farm structures and arranges for the proper wiring for light, heat, and power in the farmstead buildings.

The installation of adequate wiring as far as a job is completed is accepted as the correct method to follow in farm wiring. With this rule established, then the responsibility remains with the agricultural engineer in planning the buildings so that the appliances will be located to best advantage. This statement is very comprehensive. It means that consideration should be given to every piece of equipment, fixture, and device to be used in or near every building on the farm, as well as every light and outlet. The comparatively simple task of placing the switches is a worthwhile study on each building plan.

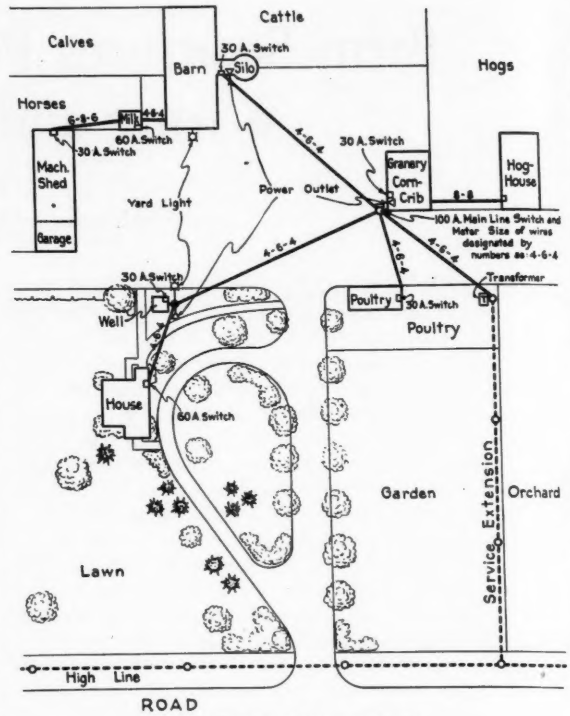
The statement is made in AGRICULTURAL ENGINEERING for November that there are more than 250 applications of electricity on the farm, including the farmhouse. With this number to consider it is evident that every structure, and even fences are to be included, must be planned differently if they are to be well planned for electrification. A fence does not need as many posts when electrified. A building when electrified may easily dispense with some windows.

We may easily reason that because there were changes in the past, there will be even greater improvements in the future. The adaptation of the airplane tire to the tractor may serve as an example of how in a similar way electrical devices of industries will be adapted to use in agriculture. In every case the success will depend in part on the proper place being made for the appliance whether it be in the kitchen or in the milk house. The modern kitchen with its electrical appliances will soon become unsightly and unhandy, if there is not properly planned storage space for each beater, mixer, chopper, squeezer, etc., that has become the joy of the housewife in recent years. The importance of having these appliances at hand when wanted and easily replaced each in its proper place when not in use can hardly be overemphasized. Of course there are clocks, thermostats, timostats, fans, fly screens, ventilators, mangles, irons, vacuum cleaners, heaters, and many others, not even to mention the electric stove and electric refrigerator, which the present house designs already include in their planned space.

The use of electricity on the farm brings many new changes at the barn. It makes certain that water will be available. There will be a number of power requirements that need to be decided before the plans are made. The milking machine, silo filler, feed grinder, and ventilators are a few of the uses in the barn, while at the milk house cooling is well taken care of by circulating pumps and refrigeration coils, as well as water heating for sterilizing the dairy utensils. The new equipment in this line helps to step up immediately the sanitation that is possible and raises the price that will be paid for dairy products.

Each improved method of performing farm or farm home operations that is introduced because of the installation of electrical equipment requires a study on the part of the agricultural engineer. He must plan the buildings and the farmstead so that there will be the utmost efficiency combined with good appearance when the new installation is put in service. The electric pump serves as a good example. It usually raises the standards of sanitation in the home because of the ease with which running water is secured. The fact that the water is used in large quantities may bring in new problems as it may cause dampness from sweating of the cold water pipes, water softener, and water closet tanks.

The basement in some sections of the country, if kept dry, becomes with electrification an important part of the house and needs to be carefully planned. In addition to the storage of fruit, vegetables, and fuel, equipment may be installed for the laundry work and work space set aside for the handy man in winter. This latter use is possible only when electricity is available for proper lighting. Such possibilities increase the importance of well-located and well-planned grade entrances and stairs.



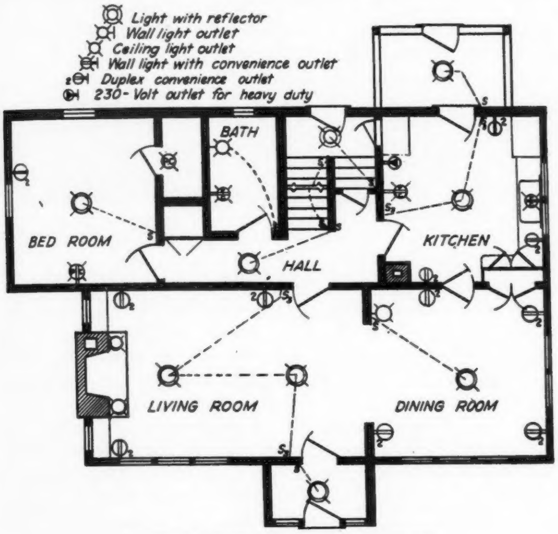
A FARMSTEAD WIRING DIAGRAM

The first floor of the farmhouse has been electrified by means of chandeliers, side, floor, table, and similar lamps and outlets for lamps, sewing machines, cleaners, and kitchen appliances in astounding numbers. After these are all in place the owner generally wishes outlets, lights, and switches were more properly placed as regards convenience and appearance. This is a challenge to the house planner to know and consider all the devices that are to be used in the house and arrange his plans so that there will be no need for changes.

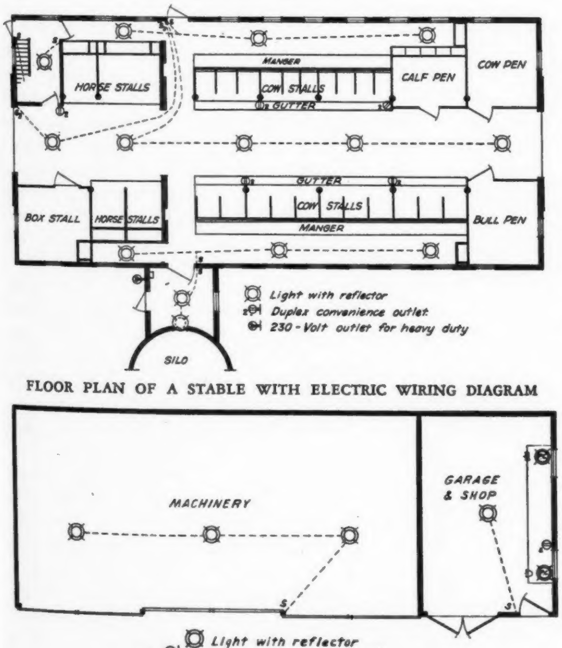
The second floor plan must be so arranged that light will be available in going from room to room without turning back to switch off lights. Closets and bathrooms may be satisfactory if small, when they are well lighted. A pull-chain lamp just above the door inside each closet is considered satisfactory now. It will in the newer houses light when the door is opened. The bathroom at its best is now an attractive part of the house but it will be planned to be more convenient in the future. More storage space and fewer materials to clean and more electrical gadgets are coming. Make a place for everything when you plan and then the easiest place to put the article is where it belongs and which was thought out beforehand. One can readily foresee when all lamps will be located back of the wall and ceiling surfaces so that there will be no dust-catching parts in the house of the future.

The barn when electrified shows a trend toward the pioneer's general-purpose building. Bringing the stock and their feed under one roof or into connected buildings

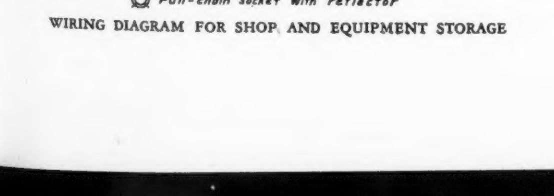
does away with inconvenience and hard work when caring for the animals. Electrical equipment permits of elevating grinding, and mixing of rations all in the same structure with the animals. Even more radical changes may occur on the farm where electrification may make it possible to store cut-up corn and hay in steel silo-like structures and the feed grinding and mixing to be done in an adjoining one-story feed room. Then, too, the future barn will be more sanitary, especially the part where milking is done, whether this is an apartment in the stable or a building connected to it. The standards of milk handling can be easily raised when hot water is made available automatically. Then, too, the light barn or milk house will usually be a clean building. Milking machines, separators, sterilizers, and coolers all need to be properly located, and there are many new plans being developed and tried out to get the best results with such electrical equipment.



A TYPICAL FARMHOUSE WIRING PLAN



FLOOR PLAN OF A STABLE WITH ELECTRIC WIRING DIAGRAM



WIRING DIAGRAM FOR SHOP AND EQUIPMENT STORAGE

Every building on the farm will be redesigned in the next few years, and electrification will undoubtedly have much to do with the new arrangements that will be incorporated in the new farm buildings. The house and barn have been mentioned briefly. They will be more radically changed than anyone considering this future development will be able to conceive. Hence, it is difficult to make statements at this time as they might seem too visionary. The radio is scarcely twenty years old, yet it is found in many farm homes and it greatly influences the attitude toward new ideas and new equipment. The electric refrigerator came along and is changing more house plans than had been improved in the previous half century. The house and barn are not the only structures to be influenced by electrification. The poultry house has been surrounded in the past by wires to keep the poultry from straying away. Now wires are inside the building and warm the water, awaken the laying hens, and light their scratching space while they eat their breakfasts.

The farmer with his mechanical equipment finds his implement shed, garage, and shop wonderfully improved the moment two or three wires extend into them. Here, again, light and power change the condition wonderfully. Light that can shine up underneath a car or tractor encourages the farmer and his sons to keep the machinery in condition. The opportunity to work with good light in the shop makes it important that there be well-planned space for workbench, grinder, anvil, and drill. Shelves, tool cabinets, and racks are necessities in the modern farm shop and need to be carefully planned.

Milk houses may be modernized and besides cooling the milk do away with the icehouse altogether. The electrified milk house if well-planned takes out of the farmhouse a lot of the muss and dampness that goes with handling dairy utensils.

In some sections the corncrib and granary will be changed if power is available for elevating, cleaning, and grinding. The ease with which one man can handle grain, feed, and corn with electric motors encourages the agricultural engineer to plan with great care the details of such structures, so there will be no place where hand work is necessary in moving the crop into storage and out again as seed, feed, or cash crop.

The use of a motor for sawing wood, mixing concrete, shelling corn, and hoisting hay may require some adaptation of the buildings to make the jobs businesslike and safe. These and other uses are being developed and suitable outlets at the various buildings are important. The installation of the hoist at the time the barn is erected usually insures a better and more workmanlike job than if done after all stagings are down and painting is completed. Future plans of farm buildings will more and more show wiring diagrams and include outlets where portable motors are to be plugged in for power. The carefully made plan will avoid the use of unnecessary conduit on the outside of a structure where they are in the way and unsightly. Even such installations as electric hotbeds and insect traps must be included and avoid unworkmanlike extensions from the buildings after they are built, wired, and equipped.

Probably no other piece of equipment on the farm means so much for improving the satisfaction of living on a farm as the electric pump. It deserves careful care in its installation so there will be no danger from polluted water and no shortage of water due to freeze-ups or interrupted electric service.

Low Cost Farm Homes from Small Logs

By S. A. Witzel

EXTENSION AGRICULTURAL ENGINEER, UNIVERSITY OF WISCONSIN. MEM. ASAE

LOW-COST housing calls for more than a sharp pencil when we think of satisfactory homes for the very few dollars available to pay for them in the northern part of Wisconsin, where farms are being developed under difficulty due to the distance from market, small clearings, lack of capital, and even lack of good timber.

When we obtain low-cost housing under these conditions, we must resort to the use of local materials which may require considerable labor, but which involve little or no cash outlay. There was a time when timber was plentiful and building material cheap in northern Wisconsin, but since timber exploitation has been completed and forest fire devastation has followed—in some instances not once but several times—good timber is no longer to be had and lumber is frequently shipped in from the South or from the west coast.

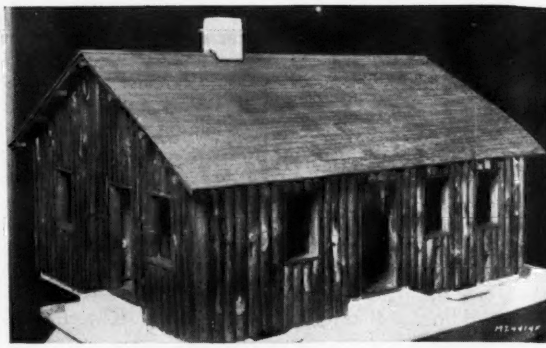
On and surrounding the farming areas in the northern one-third of Wisconsin, there are forest lands now carefully and effectively protected against fire. In these areas nature has provided a nurse crop for conifer and hardwood forests. This nurse crop is poplar, and it serves two purposes. First, it seeds itself readily in light soils after fires and rebuilds the soil. The soil humus increases from decomposing poplar leaves, increasing the soil moisture, and the poplar makes more rapid growth. The second function of poplar in reforestation is that it provides cover and protection for young growing trees of the conifer and hardwood species.

From the foregoing discussion, it is obvious that local building wood for the present and some years to come will be poplar. This material is used commercially for excelsior, but poplar logs for excelsior have such a low value that they can seldom be logged at a profit. Other commercial uses of poplar are small, and it does not make the most satisfactory kind of firewood. Poplar is a soft, easily worked wood, but little used for building purposes because of the small size of most trees at maturity, which is up to about 10 inches in diameter with the 4 to 8-inch size most common. Poplar trees branch out low, but good 8 and 10-foot logs are plentiful.

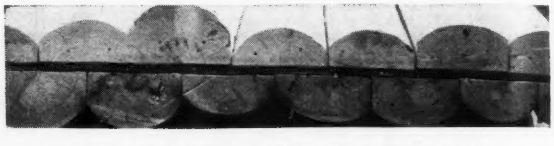
Because of the widespread and promising continued supply of this species of tree in northern Wisconsin, it seemed advisable to try to develop a kind of construction adapted to it, which would also be satisfactory for the smaller trees of any species, but with greater strength and higher resistance to decay.

In travelling through northern Wisconsin, I inspected two new summer cottages built with heavy slabs of logs which had been edged, grooved, and fitted together in a vertical position with a spline in the groove and the sawed surface on the interior of the house. This type of construction had some definite advantages, in that no framing was used for the walls, although some bracing would have been advisable. Furthermore, the short logs from small trees could be ripped down the center, edged, and stood vertically, thus using the size of log obtainable from poplar. In order to provide a warm and more stable wall a double construction with split logs sawed face to sawed face with waterproof building paper between was devised.

Presented before the Farm Structures Division of the American Society of Agricultural Engineers at Athens, Georgia, June 1935.



MODEL OF A HOUSE OF DOUBLE RIPPED-LOG CONSTRUCTION



TOP VIEW OF A WALL OF THE DOUBLE RIPPED-LOG TYPE

The ripped logs may be of different widths, but care is necessary in building up the wall so that the joint between the logs would fall in about the center of the log on the other side. The wall is well nailed from both sides, and the nails are driven as near to the edges as possible to insure the necessary strength and rigidity.

The USDA Forest Products Laboratory at Madison co-operated in this development. They constructed and tested a full-sized 8x10-foot panel of double ripped-log construction and found it to be one and one-half times as strong as an ordinary construction of horizontal sheathing. This would be strong enough for one-story buildings. However, should greater rigidity be desired, a 4x8-foot panel of 1/4-inch plywood could be built into the wall at each corner.

A wall of the double ripped-log type, an average of 4 1/2 to 5 inches in thickness and containing one or two layers of heavy waterproof building paper, will provide sufficient resistance to the transmission of heat and the entrance of cold air to make a comfortable and easily heated building through the long cold winters. The insulation value is about equal to that of ordinary house construction with sheathing, paper, and bevel siding on the exterior and 1/2-inch insulation board with 1/2-inch plaster on the interior.

Some objection has been raised to the rough interior, so further improvement in the design suggested 1/4-inch plywood applied to the interior wall. This plywood may be secured to furring strips, or the ripped logs could be cut to a standard thickness by taking off a thin slab from the face of logs used on the interior.

The ripped-log plan of construction provides good building features which will make these structures last. Such features are not possible with horizontal log houses. The Forest Products Laboratory assisted in suggesting construction features and creosote treatment for outside split logs to insure freedom from decay hazards so commonly found in log buildings.

The ripped-log type of construction offers the people of northern Wisconsin the ultimate in low-cost construction, in so far as cash outlay for material is concerned. On a stone foundation, framing and subfloor are provided, and the joists may be of edged logs *(Continued on page 40)*

Facing Facts of Farm Electric Service

By J. D. Noyes

ENGINEER, DETROIT EDISON CO.

IN UNDERTAKING to discuss some of the questions of rural electricity supply, I do not promise that all of the comments I will offer will contribute to the feeling of optimism and sunshine supposed to prevail in a discussion of this subject.

The question of farm electrification is an old one with almost all progressive utilities. Most of us have had farm service organizations in our sales departments for many years; ours is seven years old. The men of these divisions know the farmer's problems and talk his language. There is a long record of utility interest and support of study and research upon this subject, both by national committees and by individual company relationships with agricultural schools, colleges, and farm organizations. The social importance of bringing electricity to the farm has long been realized, but long experience has also compelled appreciation and concern with some of the problems and difficulties involved.

Public interest in the subject has been greatly stimulated in recent years. In view of the large amount of reliable information available, we are sometimes compelled to wonder about the sources and effects of the stimulants used—and in somewhat the same fashion as some of us used to speculate upon the probable results of the prohibition-era drinkables. We hoped and used to trust that everything would turn out all right. Usually this proved to be the case, although there were occasional disastrous occurrences.

I think it is quite generally assumed that some one must in some way pay for farm electrification—it is one of those things that is not a free gift of Providence. I still think the assumption is correct, but I am by no means as certain as I used to be who the some one will be, or by what means it will be done. You will, of course, appreciate my difficulties when I say that I was brought up to believe that in as far as it was possible a utility-rate schedule should collect from each class of customer all of the cost of serving him plus a reasonable contribution to the cost of carrying on the business, and that no class of customer could be served at a loss and those losses collected from other customer classifications. Commission and court decisions in support of the theory exist on several miles of legal bookshelves. Recent aspects of the discussions of farm electrification compel me to pause and wonder as to the further acceptance of this previously well-established theory of rates.

As I said, I used to think that the person who would pay for electrical use on the farm was the farmer in question. It is beginning to appear that it is quite difficult for him to do this, and since there appears to be a general feeling that he ought to have the benefits of such use, other means of paying the bill are being sought, sometimes in strange places; at least they appear strange in the light of the before-mentioned rate theory.

The cost of rural-line construction, under favorable conditions, ranges upward from $1,000 or $1,200 per mile. In difficult territory it will be much more. If we assume four farms per mile, and this is a high figure,—the average of remaining areas cannot reach this,—the investment per customer is $300. If the over-all gross earning rate is 15 per cent, each customer should pay $45 a year. But the investment in a rural-line extension by no means covers all investment costs. What of distribution substations, the high-voltage cable, or tower-line supply feeders to them, and the power house back of it all? What will be the attitude of regulatory bodies having jurisdiction over utility rates toward such a situation? How do you think the other customer groups will regard the program?

Our company now supplies over 68 per cent of all farms in its territory—about 15,000 farm customers. The average use (1934) is 766 kilowatt-hours per year; average rate, a little under 4 cents; annual bill, $30.64. This includes free lamp renewals and a number of other items of consumer service, like fuse calls, minor repairs to utilization devices, and the like. The rate makes long-hour use available at 2½ cents per kilowatt-hour gross; 2¼ cents net. This step is reached after use of a relatively small amount (say 2 kilowatt-hours per day) at the preceding higher steps. The rate compares favorably with that given other long-hour users.

The 1934 average use by all our residence customers—over 450,000 of them—was 717 kilowatt-hours.

We wonder if this leads to the conclusion that average farm use in our territory will not greatly exceed that of the average residence and that the importance, value, and possibilities of large consumption per farm is much overestimated. We fully appreciate the social value of electricity on the farm—the part it plays in labor saving, comfort, sanitation, and safety—but we wonder if its basic economic importance is not greatly overemphasized. It would seem that, if this was as great as is often claimed, the fairly prosperous farmers of our territory now having service would find use for many times their present average con-

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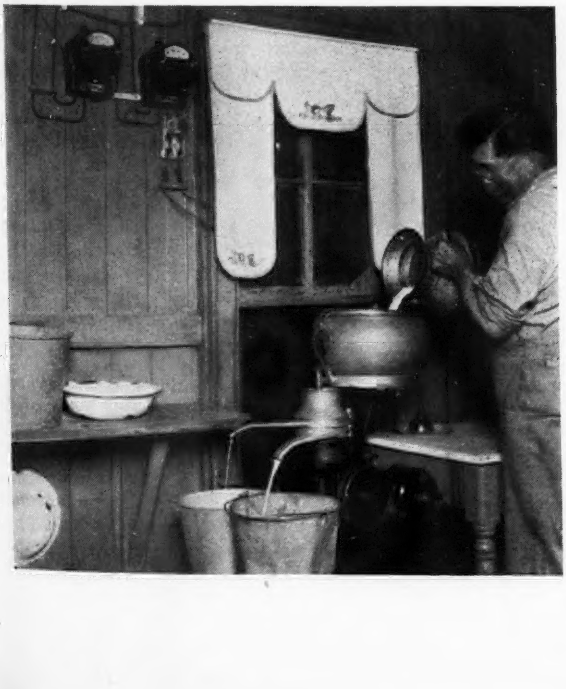
Presented before the Rural Electric and Farm Structures Divisions of the American Society of Agricultural Engineers at Chicago, December 1935.



sumption. Nevertheless we have, as a part of our contribution to the development of the territory we serve, built over 500 miles of rural-line extensions in the first ten months of 1935.

In your consideration of these problems I invite your attention to several factors which I suggest have not been properly studied and evaluated. You will note that some of these are sociological problems rather than matters of engineering.

1 It takes a long period of time and intensive promotional effort to change age-old habits of living. This applies to any group—and almost any group you select would be far less individualistic than the farm group. It required some thirty-five years to replace gas lighting with electric light, and today we are learning that much still remains to be done.

2 There is a great deal of farm labor that cannot, in the present state of the art, be done electrically. The machinery is not available, or the best machinery for the job is not electrically driven. It happens these are the heavy power jobs—plowing, cultivating, hauling are typical.

3 While we realize the many advantages of electrical use, we must realize also that some part of the farm income must be alloted to its purchase. In round figures, it is going to cost $1,000 per farm for wiring, appliances, and equipment, including a simple water supply system and plumbing. This is 35 times the annual power bill, commonly paid in the territory of my company. The electric stove is in many ways superior and is certainly more convenient than the wood-burning range, but how much is that worth to the farmer who owns his own woodlot?

4 The preceding paragraph immediately raises the question of farm income,—and I mean here cash income available for the payment of obligations requiring that sort of outlay. Electricity is only one of these—taxes, maintenance of machinery and equipment are others. Without in any way detracting from the many benefits and advantages of farm life, it is possible to paint a rather gloomy statistical picture of farm income expressed in hard cash. You are familiar with the details. I have some personal knowledge of the matter. My grandparents were fairly prosperous farmers of central Wisconsin. No one of that family ever lacked any of the real necessities of life. The children went to school—some to college. But the money required for the then modest tax bill was a very real and carefully planned for problem.

Perhaps the farmer as a group should have a greater cash income. Perhaps other groups—you and I—should be directly taxed to provide for the increase. I am afraid I do not know the answer, but this is the real basic problem of rural electrification: To find ways and means of raising farm income and farm standards of living to a point where expenditures for electrical use become possible of inclusion in the family budget without sacrifice of other and perhaps more essential comforts and necessities of life.

COMMENTS ON NEW AND IMPORTANT DEVELOPMENTS IN FARM WIRING

The most important development in farm wiring over the last year or two has been a growing realization of the limitations and disadvantages of the conventional types of metal-clad wiring for use in and about farm buildings. As a result, and in spite of a good deal of opposition, several things of considerable importance have occurred.

The National Electrical Code will no longer place unreasonable restrictions upon the use of standard types of non-metallic sheathed cable. The rules regulating such use were liberalized at the March 1935 meeting of the Electrical Committee, N.F.P.A., and will appear in the code revision now being distributed and effective in most places the first of the year.

The same code revision also gives recognition to cable assemblies for electric ranges having an uninsulated neutral in a non-metal enclosure or covering.

It is reported that the wire and cable manufacturers are preparing to bring out a new type of small diameter non-metal cable assembly which should prove particularly valuable for all house wiring, including farmhouses and other farm buildings. The essential feature of this cable is its small outside diameter (about 1/3 inch) and the use of a stranded neutral wire wrapped concentrically around the central hot wire. The cable, being small and flexible, can be easily and rapidly installed, securely fastened in protected corners or against the surface and easily fished through small openings and spaces in building structures.

There is a very good description of the application of this material, with illustrations, in an article by M. H. Lloyd in AGRICULTURAL ENGINEERING for November 1935.

The new wiring material can be used with standard steel boxes and standard outlet devices. The development of non-metallic boxes, or the elimination of the box by suitable modification of the device body to hold the cable and enclose terminals, is being considered. The importance of a non-metal box is, in my opinion, somewhat overvalued as a safety feature. Troubles on metal armored wiring systems were due to the transmission of stray potentials from insulation failures through the armor to other metal structures, water piping systems, metal cow stanchions, and the like. An isolated metal box, especially when mounted on wood work, is not a serious hazard, even in the remote case of having potential on it from an insulation failure inside.

Protective grounding of the metal enclosures of wires, either through the armor or by a separate grounding conductor has not always proven to be infallible. A high-resistance breakdown of insulation, or high resistance due to faulty connections in the earth circuit, may so limit the current that the hot-wire fuse does not blow and so potential remains on the armor.

The actual hazard, either to life or property, of low-voltage electricity supply is relatively very small. In a report to the Industrial Commission of Wisconsin on fires in 1934, electric wiring was ranked sixteenth in the list of causes and charged with 1.2 per cent of the total number of fires. Of the country's total annual fire loss in dollars, electrical fires are charged by insurance statistics with something less than 4 per cent. Thus the 1933 figures—the latest available—are as follows:

Total	$217,162,551.00	
Unknown causes	101.0	million dollars
Matches and smoking	14.4	" "
Defective chimneys and flues	14.15	" "
Stoves and furnaces	12.8	" "
Electrical causes	7.9	" "

A careful study of the electrical fire record has been under way for several years. It early appeared that many fires were incorrectly charged to electricity, and that substantial losses occur in risks not concerning the electric light and power industry. Bad workmanship or violations of Code rules occurring in spite of the Code and inspections thereunder account for a considerable amount. It appears quite reasonable to suppose that the most rigid code that could be devised, strictly enforced, would not operate to reduce the annual loss 10 per cent. *(Continued on page 28)*

An Improved Non-Metallic Sheathed Wiring Installation for Rural Buildings

By V. M. Murray and L. C. Larson

COLLEGE OF ENGINEERING, UNIVERSITY OF WISCONSIN

IT WAS the original purpose of this study to attempt to evolve a method of wiring rural buildings which would meet the requirements peculiar to this type of structure and at the same time use only wiring materials and devices now on the market. The system developed, then, would be new only in the sense that it may be a new arrangement of existing materials and devices. This plan was adhered to as closely as possible but, as will be shown, it was speedily discovered that the solution lay in completely sheathing the entire installation in a non-metallic, insulating covering. Since outlet boxes of such material were not manufactured, it was necessary to design and have built boxes of the desired type. These boxes are now on the market so that it can now be said the original object has been attained.

The method employed in this study was

1 To determine by an examination of available literature, by personal scrutiny, and by correspondence and conversation with owners of rural buildings, electrical inspectors, electrical contractors, and engineers of electric utilities what were the special requirements of a wiring installation for rural buildings

2 To determine, from the same sources, how the present methods of wiring fulfilled or failed to fulfill these requirements

3 To develop a method of wiring as similar as possible to the existing methods but without the disadvantages noted under (2), this development to be carried out to the extent of making an actual installation of the new system.

This report will be divided into three parts on the basis outlined above.

The one type of rural building which presents the most interesting and singular wiring problem is the barn used to house livestock. A study of other rural buildings shows that the wiring of them will present no important problems not encountered in the wiring of such a barn. Attention, then, should be focused on barn wiring.

For instance, the wiring in the vast majority of such barns is fully exposed. This involves not only the protection of the conductors from mechanical injury, but also the protection of persons and livestock from electric shock (Table 1). Such shock is generally caused by the unexpected existence to ground of a potential not exceeding 110 volts. For human beings such a shock may be merely uncomfortable, but for the average farm livestock it is highly dangerous and very probably fatal[1,2,3].

Again, barn wiring, if it is to have a reasonably long life, should be highly resistant to the corrosive actions of *moisture* caused by condensation from the humid atmosphere of stables; *gases*, such as ammonia fumes; and *disinfectant compounds* with which dairy barns are often sprayed (as is required, for instance, in the Chicago milk shed area).

A third requirement is that the initial cost of the installation should be low. This is of prime importance to the rural consumer because

1 The total cost of utilizing electrical energy to which this type of consumer is subject is higher than for most other types, since it must include such additional items as contribution to the line, yard poles, and feeders to the various buildings

2 A large building, such as a barn, is inherently expensive to wire because of the extremely long "runs" of conductors between outlets

3 The buildings to be wired generally represent income producing property and any additional expense should be examined in the light of expected increase in revenue.

Finally, the fire hazard introduced by wiring the building for electricity should be very small. It is the opinion of the authors that this hazard is very small with the methods now in use. Indeed a study of approved methods and devices makes it extremely difficult to understand how the permanent wiring of a building can cause a fire[4]. This opinion is further strengthened by a recent detailed study of the fires in Wisconsin for 1934 which shows that (1) the permanent wiring could not have produced more than 1.2 per cent of the total of 9295 fires for that year, and (2) over 60 per cent of the total fires in the state are accounted for by fifteen causes which must be listed ahead of permanent electric wiring[5].

It would appear, then, that a good wiring system for rural buildings (particularly barns housing livestock) should

1 Offer adequate protection of the conductors against mechanical injury

2 Afford little possibility of shock to persons or livestock

3 Be highly resistant to the corrosive elements present

4 Be as inexpensive as possible

5 Offer little hazard due to fire.

There are at present three methods of wiring in general use, namely, rigid conduit, armored cable (BX), and knob-and-tube (open wiring). It is proposed to examine each of these in turn in the light of the first four requirements

Presented before the Farm Structures and Rural Electric Divisions of the American Society of Agricultural Engineers at Chicago, December 2 to 4, 1935. (Also presented before the Wisconsin Utilities Association at Green Bay, Wisconsin, November 11 and 12, 1935.)

[1]Electrical Stunning of Cattle, by H. J. Koenig. A paper presented at a meeting of the Operating and Engineering Section of the Institute of American Meat Packers. October 17, 1930.

[2]Electrical Stunning of Hogs, by R. W. Rogensburger. A paper presented at a meeting of the Operating and Engineering Section of the Institute of American Meat Packers. October 17, 1930.

[3]Records, either published or available for inspection, of Industrial Commission of Wisconsin, Hydro-Electric Power Commission of Ontario, Low-Voltage Hazards Sub-Committee NELA.

[4]A Study of Standard Wiring Materials as a Basis for Improvement of Wiring on the Farm, by D. E. Graves. A thesis for the degree of master of science on file in the main library of the University of Wisconsin.

[5]Permanent Electric Wiring of Buildings as a Cause of Fires in Wisconsin during 1934. A report of a survey by V. M. Murray made to the safety division of the Wisconsin Industrial Commission, June 24, 1935. (Not available in published form.)

listed above. The item of fire hazard is omitted for the reasons already given.

Rigid Conduit. Probably no greater protection can be given the conductors against mechanical injury than to surround them with a rigid steel wall as furnished by rigid conduit. The protection of the conductors is certainly adequate. There is, however, some question as to the adequacy of the protection given persons or livestock against electric shock. Ideally, the conduit forms a continuous low-resistance electrical connection from the far end of any circuit to the grounded neutral bus in the cut-out box. In actual practice this is often not the case. High-contact resistance at junctions—particularly outlet boxes—makes it quite possible for a section of conduit to become "alive" while not permitting the passage of sufficient current to clear the fault by "blowing" the fuses.

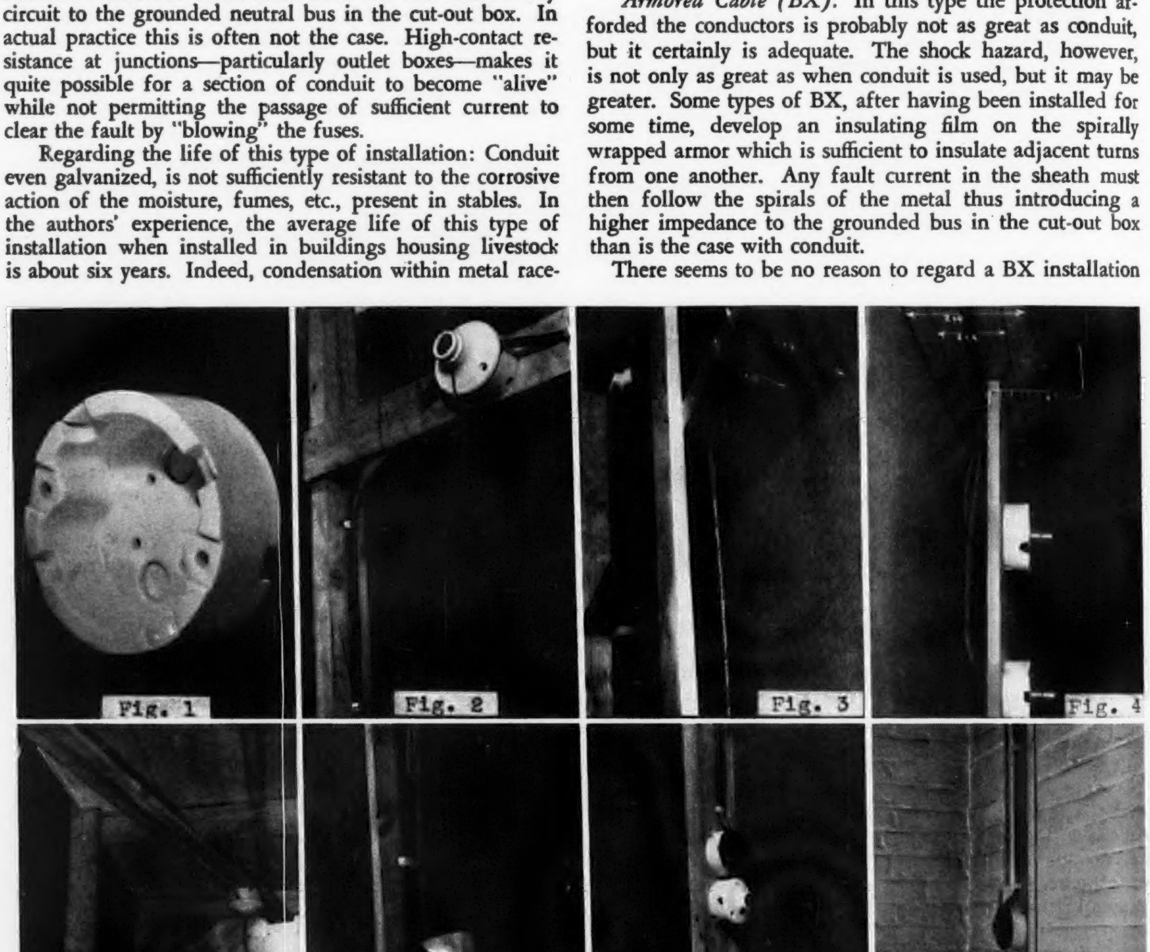
Regarding the life of this type of installation: Conduit even galvanized, is not sufficiently resistant to the corrosive action of the moisture, fumes, etc., present in stables. In the authors' experience, the average life of this type of installation when installed in buildings housing livestock is about six years. Indeed, condensation within metal raceways and boxes is so severe that it is now common practice to specify drain holes in the system.

As regards initial cost, conduit is the most expensive of all three methods of wiring. This is caused, not only by the high cost of the conduit itself (the pipe), but by the large labor costs incurred in installing it.

Rigid conduit, then, while offering excellent protection to the conductors, has considerable shock hazard, is short-lived, and very expensive.

Armored Cable (BX). In this type the protection afforded the conductors is probably not as great as conduit, but it certainly is adequate. The shock hazard, however, is not only as great as when conduit is used, but it may be greater. Some types of BX, after having been installed for some time, develop an insulating film on the spirally wrapped armor which is sufficient to insulate adjacent turns from one another. Any fault current in the sheath must then follow the spirals of the metal thus introducing a higher impedance to the grounded bus in the cut-out box than is the case with conduit.

There seems to be no reason to regard a BX installation



FIGS. 1 to 9 VIEWS OF THE LABORATORY MODEL OF THE COMPLETELY NON-METALLIC SHEATHED INSTALLATION

FIG. 1 The second experimental porcelain outlet box. The final form of the box is as shown except that the porcelain knockouts are made flush with the top. FIG. 2 Looking up at a side wall outlet 7 ft 2 in above the floor. Since this is above the 7 ft level, no protection is given the cable. It is fastened on the outside of ¾x4-in stripping. Note that the vertical run of cable, since it does go below the 7-ft level, is fastened directly to the inner surface of the studding. FIG. 3 Looking down from the ceiling on a cable passing horizontally through the studding of the side wall at a height of only 4 ft above the floor. It is protected by ¾x4-in wood strips nailed to the studding in front of the cable. FIG. 4 Looking directly down on a pair of switch outlets, showing the adequate protection afforded the cables by the ¾x6-in board on which the boxes are mounted. This mounting will accommodate five such outlets. A much simpler mounting is possible for a single switch as is shown in Figs. 6 and 7. FIG. 5 Looking up at a ceiling outlet. Note the ¾x4-in wood strip to which the cable is fastened. The lamp socket shown is of bakelite. FIG. 6 A simple form of mounting for a switch. The box is fastened to a 5x5x¾-in wood block which has been nailed to the siding of the barn. FIG. 7 A method of mounting a switch and/or a convenience outlet recommended where the width of the wall studding is greater than the diameter of the box. (2x6-in studding, for example). FIG. 8 Switch mounting on a brick wall. Note the protective wood strip alongside the cable. FIG. 9 (Opposite page) A fused service switch and four-circuit cut-out box. Note the protection given the cables by using the knockouts in the back of the switch and cut-out boxes

as more resistant to corrosion than conduit. It is, however, very much cheaper installed.

To summarize, a BX installation has well-protected conductors and is very much cheaper than conduit. It does, however, offer considerable shock hazard, and it is short-lived.

Knob-and-Tube. This method affords no protection to the insulated conductors except that which can be obtained by mounting in sheltered places and by using protective strips of wood. There is, though, very little possibility of obtaining a shock from the installation largely because the amount of metal sheathing has been greatly reduced; only the metal outlet boxes and their metal covers remain to constitute any hazard. For the same reason, the life of the knob-and-tube installation is much longer than either of the other two. As regards cost, knob-and-tube is the least expensive of the three.

It is the studied opinion of the authors that, of all the present methods of wiring rural buildings, knob-and-tube (when carefully installed so as to obtain adequate protection for the conductors) is the best.

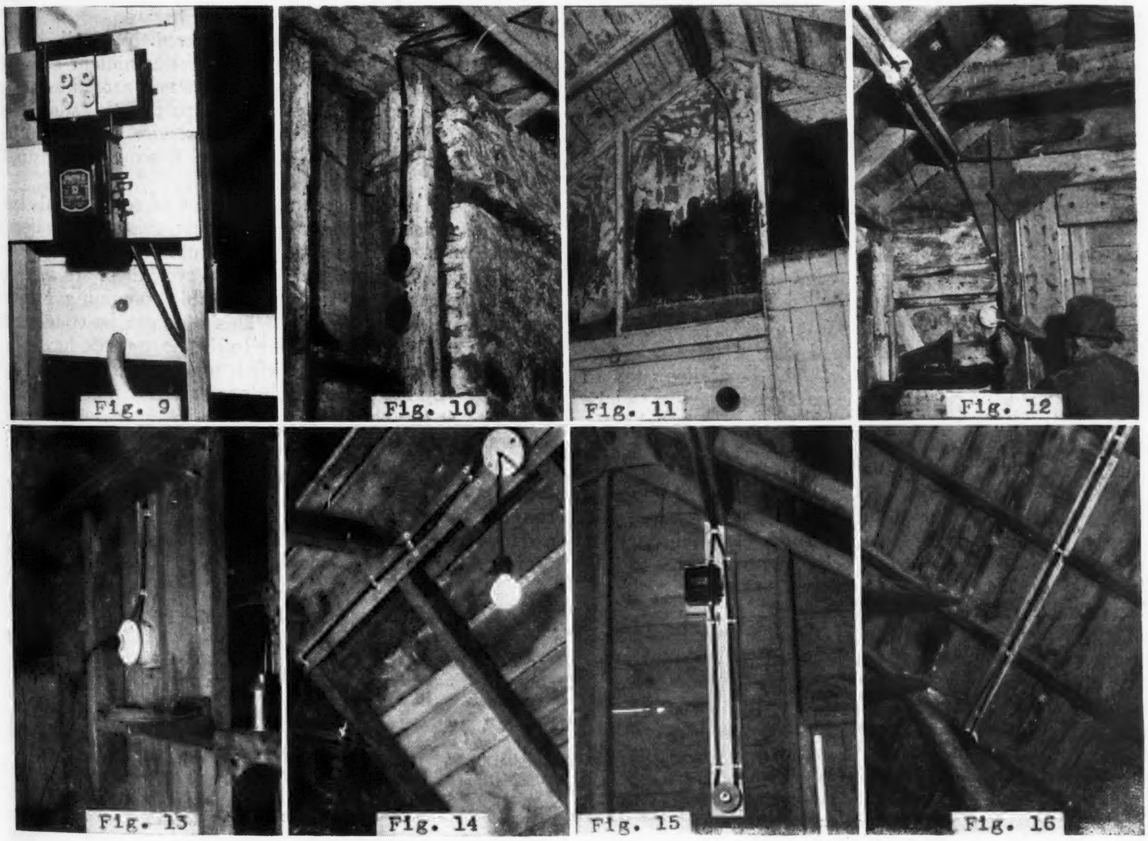
THE COMPLETELY NON-METALLIC SHEATHED INSTALLATION

In the last analysis, the problem of developing a wiring system suitable for rural buildings becomes little more than so improving the knob-and-tube method as (1) to obtain more protection for the conductors and (2) to eliminate entirely the small shock hazard and the corrosion caused by the presence of the metal outlet boxes. In other words, to completely sheath the installation, but to do it with non-metallic materials.

It is now proposed to describe in detail one method in which this was accomplished.

Conductors. The type of conductor used was the approved non-metallic sheathed cable sold under various names such as Romex, Braid-X, Cablex, Durax, etc. Such cable can be obtained in the following forms: two No. 14 conductors, two No. 14 conductors with a bare ground wire, three No. 14 conductors, three No. 14 conductors with a bare ground wire, or the above combinations with other wire sizes. (A new type of non-metallic sheathed cable, tentatively called "protected neutral concentric cable," is now being manufactured, and is even more compact and requires less protection than the types listed here.)

By using such cables, not only were the insulated conductors protected by the outside braid, but cables could be mounted snugly against a surface and not away from it as in knob-and-tube wiring.



FIGS. 10 TO 16 VIEWS OF THE COMPLETELY NON-METALLIC SHEATHED INSTALLATION MADE ON THE B. W. QUALLEY FARM

FIG. 10 Switch mounting adjacent to the barn door on the Qualley Farm. Although the wall is of stone, there is sufficient frame construction around the door to permit the placing of the boxes and cable in a sheltered position. FIG. 11 Looking up at a portion of the installation in the chicken house. The steel box shown contains the fused entrance switch. On the inside the wall of this building was boarded up to a height of 5 ft. FIG. 12 Installing a drop-cord and switch outlet in the garage. In order to gain the desired protection for switch and cable, it was necessary, in this case, to mount the outlet higher than usual. FIG. 13 A convenience outlet in the milk house. (Standard porcelain box covers were used wherever possible.) FIG. 14 A ceiling outlet in the milk house. FIG. 15 The entrance switch and a 3-way switch outlet in the hog barn. FIG. 16 Looking up at a long run of cable mounted on the roof rafters of the hog barn. In mounting this run, the cable and outlet boxes were first fastened to the wood stripping and then the whole assembly lifted up and nailed to the rafters.

TABLE 1. A SURVEY OF THE WIRING SYSTEMS IN 172 RURAL BUILDINGS IN BURKE AND SUN PRAIRIE TOWNSHIPS, DANE COUNTY, WISCONSIN (JANUARY, 1935)

Type of building	Concealed					Exposed					Totals
	Rigid conduit	BX	Romex	Knob and tube	Not known	Rigid conduit	BX	Romex	Knob and tube	Not known	
House	13	26	5	8	7	0	0	0	1	0	60
Barn	4	0	0	0	0	34	7	1	5	0	51
Chicken house	3	0	0	0	0	8	4	0	4	0	19
Other buildings	8	0	0	0	1	22	6	2	3	0	42
Totals	28	26	5	8	8	64	17	3	13	0	172
Installations from which shocks have been experienced during past year	0	1	0	0	0	6	2	0	0	0	9

Summary:

Buildings having exposed wiring, 56.4 per cent
Buildings having rigid conduit wiring (either concealed or exposed), 53.5 per cent
Buildings having BX wiring (either concealed or exposed), 25.0 per cent
Buildings having non-metallic cable wiring (either concealed or exposed), 4.65 per cent
Buildings having knob-and-tube wiring (either concealed or exposed), 12.2 per cent
Buildings having unknown type of concealed wiring (probably knob-and-tube), 4.65 per cent

In installing the cable two general rules were observed (1) Wherever possible mount the cable directly onto wood stripping so as to give it a solid backing, and (2) protect the cable when it is within 7 feet of the floor. The application of both rules is shown in Fig. 2.

The cable was said to be sufficiently protected if (1) mounted back against the siding of the building, the projecting studding furnishing sufficient protection (see Fig. 13); (2) mounted on the larger flat surface of the 2x4 or 2x6 studding (see Figs. 6 and 7); (3) a strip of wood is fastened alongside the cable in such a manner as to project above the cable (see Fig. 8); (4) for horizontal runs, the cable is drawn through holes drilled in the studding at least 2 inches from the inner edge and a piece of stripping at least 3/4 by 4 inches is nailed in front of the cable (see Fig. 3).

Outlets. The outlet boxes used were all of a new type developed as part of this study. The box, illustrated in Fig. 1, is made of porcelain and so dimensioned as to take any standard 4-inch cover. It is, in effect, a 4-inch box in porcelain. The only unusual feature is the use of U-shaped cable openings instead of the usual holes. This not only gives stronger construction, but permits easier installation of the cable. No connectors were used.

Only the one type of outlet box was used throughout the entire installation—for switches, convenience outlets, lamp receptacles, and junction boxes. (The authors have been lately informed by the Standard Electrical Porcelain Manufacturers that the companies which are members of this group plan to market a complete line of non-conducting outlet and junction boxes.) Since this box was built to take a standard 4-inch cover, it was not possible to use the line of flush devices which fit in the standard sectional metal boxes. All switches, for instance, were exclusively of the surface type. (See Fig. 4).

The box covers were 3/32 inch thick and 4½ inches in diameter and made of grade XX laminated bakelite. This material, manufactured under many different trade names (Synthane, Dilecto, Formica, Spauldite, etc.) is an excellent insulator, fire-resistant, absorbs very little moisture, and, while being sufficiently strong, is easily worked. It is, however, expensive. For this reason the possibility of replacing these by covers made of asbestos-cement compounds is now being studied.

The covers are held in place by 8/32 brass machine screws. These screws are completely surrounded by porcelain and therefore constitute no shock hazard.

Grounding. Because of the extremely small shock hazard of this type of installation, the minimum amount of grounding required by the Codes was regarded as sufficient. The farm installation made as part of this study has only one ground, that at the meter service (permitted in this case by the safety division of the Wisconsin Industrial Commission).

If it is desired to ground the frame of some metal-clad appliance which is wired into the system, this could be done in two ways. One method—the simplest—is to drive a ground at the machine itself. If, however, there are several units to be grounded, the type of cable containing a bare ground wire should be used. This wire can be connected from the frame of the machine to the neutral conductor in the cut-out box or service switch used as entrance to the building. Under these conditions, *the neutral must be grounded* at the entrance to every building in which such an arrangement is used.

Costs. This non-metallic sheathed cable system has been installed on the B. W. Qualley farm near Stoughton, Wisconsin. The electrical contractor (A. M. Quam) displayed extraordinary interest in the cable system, and his records provided the data in Table 2.

TABLE 2. WIRING COSTS, EXCLUDING OVERHEAD AND PROFIT, OF NON-METALLIC SHEATHED CABLE SYSTEM

Building	Dimensions, ft	Outlets	Material cost	Labor cost	Total cost	Cost per outlet
Barn and milkhouse	34x64	13	$15.89	$20.30	$36.19	$2.78
Hog barn	18x42	4	7.84	5.07	12.91	3.23
Chicken house	15x24	2	3.69	2.17	5.86	2.93
Granary	18x26	2	3.15	2.17	5.32	2.66
Garage	12x26	3	4.50	3.62	8.12	2.71
Pump house	10x12	2	3.30	2.17	5.47	2.74
Totals		26	38.37	35.50	73.87	2.84

If the overhead costs and profit, at the rate of 25 per cent, are added to the above total of $73.87, the total cost of wiring the six buildings becomes $92.34, and the final cost per outlet (26 outlets in all) is $3.55. The cost per outlet in the barn and milkhouse alone is $3.48.

Those who are familiar with the cost per outlet in rural buildings for the armored cable (BX) and rigid conduit systems will note that the final cost per outlet in this *initial* installation employing the non-metallic cable system is approximately 18 per cent more than the cost of BX and from 50 to 30 per cent less than rigid conduit. These comparisons are based upon $3.00 per outlet for the BX method and $5.00 to $7.00 per outlet for the rigid conduit method, figures which were chosen by electrical engineers of the Wisconsin Public Service Commission as an average of estimates received from several practicing electrical contractors in and near Madison, Wisconsin.

Eventually the non-metallic sheathed system may cost 10 to 15 per cent[6] more than a comparable open knob-and-tube system, yet it is believed that widespread usage of the non-metallic cable system will result in bringing its cost considerably nearer to that of the knob-and-tube method. This cost difference is justified in the increased protection provided against mechanical injury to the wires and the procurement of a compact, neat arrangement of cable and outlet boxes.

[6]Based upon a careful comparison made between the cost of materials for the non-metallic sheathed cable system and the open knob-and-tube system using a 76x34-foot barn floor-plan providing 31 outlets in the barn. The protected neutral concentric conductor type of cable previously mentioned will effect a 15 per cent saving in cable cost.

BILL OF MATERIALS AND LABOR COSTS

(An installation in the barn* and attached milk house on the farm of B. W. Qualley, near Stoughton, Wisconsin)

	Quantity required	Unit cost	Total
2 No. 14 non-metallic sheathed cable	220 ft	2.84**	$ 6.25
3 No. 14 non-metallic sheathed cable	45 ft	4.48**	2.02
2 No. 10 non-metallic sheathed cable	5 ft	5.72**	.29
Porcelain outlet boxes	13	.11	1.43
Outlet box cover plates (ebony asbestos wood)	5	.11	.55
Porcelain outlet box covers, 4-in (for drop cords)	1	.11	.11
Porcelain keyless receptacles (for 4-in box)	7	.16	1.12
Bakelite key sockets	1	.20	.20
Bakelite single-pole surface switches	3	.11	.33
Flush type single-pole switches	1	.43	.43
Bakelite 3-way surface switches	1	.25	.25
2-pole entrance service switch	1	1.25	1.25
Brewery cord	6 ft	.025	.15
Cable straps	100	.35†	.35
Connectors, 3/8 in	2	.07	.14
Machine screws and nuts— 1½x8/32 in (brass)	26	2.00(gross)	.37
Solder, tape			.35
No. 2 white pine, 3/4x4 in	15 ft	2.00**	.30
Total cost of materials to contractor			$15.89
Labor††: Electrician— 14 hr at $0.85 per hr		$11.90	
Helper— 14 hr at $0.60 per hr		8.40	
Total cost of labor			$20.30
Total, labor and materials			$36.19
Overhead and profit at 25 per cent			9.05
Total			$45.24

Cost per outlet (45.24 ÷ 13), $3.48 (including overhead and profit)

*The barn included a full-sized haymow requiring a 50-foot run to a ceiling outlet

**Per 100 feet

†Per hundred

††Subsequent installations of this system should reduce the labor item because of the accumulated experience in technique

SUMMARY

The essential requirements of a good wiring system for rural buildings, particularly barns housing livestock, are as follows:

1 The conductors must have adequate protection against mechanical injury.

2 The shock hazard to persons and livestock should be eliminated.

3 The purchaser of the system should receive a lasting or long-life installation—a system, then, which will resist the corrosive elements present in barns.

4 The initial and annual costs should compete with other permanent wiring systems.

5 The fire hazard should be reduced to a minimum consistent with the above four requirements.

The completely non-metallic sheathed installation described in this paper meets these five requirements as follows:

1 The conductors are protected in a sheathed cable, which in turn is adequately protected by wood stripping or by the studding of the building everywhere below the 7-foot level.

2 Non-conducting cable sheathing and porcelain outlet boxes, together with porcelain or bakelite lamp sockets and box covers afford little, if any, likelihood of electric shock to either man or animal.

3 The materials enumerated in (2) resistant corrosion and should provide 15 to 20 years of good service.

4 Cost studies made of an actual installation have demonstrated that the non-metallic sheathed installation can be provided, *at present,* at a cost comparable to the cost of a BX system. The probable small increased cost over that for an open knob-and-tube installation can be justified by the extra protection afforded the conductors and the resultant compact, neat arrangement of cable and outlet boxes.

5 This system offers no more fire hazard than do existing systems, and, contrary to popular belief, permanent wiring of buildings is a minor cause of fires.

Finally, while it is the authors' opinion that all wiring installations should be made only by competent electricians, this non-metallic sheathed installation is so easy to install that it discourages the use of unauthorized and dangerous extensions.

"For Lower Wiring Costs"

To the Editor:

I APPRECIATE very much the type of editorial in AGRICULTURAL ENGINEERING for December, entitled "For Lower Wiring Costs." There are, however, a few items which I desire to call to your attention in connection with this wiring problem and the development of low costs.

You mention that some one spoke about conduit wiring as being a "racket," but advised the use of non-metallic sheath conductor. (You happened to use the word "non-conductive" instead of "non-metallic.") I would like to call your attention to material being put out by V. M. Murray and L. C. Larson of the University of Wisconsin, setting up the facilities for using non-metallic sheath conductor, but definitely calling attention to the fact that such wiring costs about 15 per cent more than open wiring. Obviously, then, the speaker who so impressed you was an advocate of non-metallic sheath conductor and a critic of conduit wiring, not because a lot of companies are rec-

ommending conduit wiring, but because few organizations are recommending the non-metallic sheath.

From the first, our company has recommended wiring of the open type in all outbuildings on the farm, and have, therefore, maintained recommendations based on the lowest possible cost of wiring. We know that many other companies are doing the same. Since there is no inspection by the state, the company must maintain its own inspection bureau for its protection and for the protection of its customers.

I would like to comment to the effect that at this time the National Electric Code has no particularly objectionable features applying to farm wiring. The administration of inspection may introduce objectionable features, since the inspector covering the job may look upon farm wiring from the viewpoint used in urban inspection.

The rural department of our company, early in its development, found that conduit wiring installed on farms previously was in extremely bad condition due to corrosion. We therefore objected to its use. Our inspectors undertook to educate the wiremen throughout the area to the effect that this wiring, while complying with the Code, was objectionable and that lower cost wiring of the open type was available under the Code plan.

Very frequently wiremen have requested permission to wire with the non-metallic sheath cable. This permission is not denied them, but their attention is called to the fact that the non-metallic sheath conductor is more expensive to install than the open type wiring recommended.

Within the last two or three years, we ourselves have definitely tried to obtain an addition to the Code. The Code now protects for fire hazard and for human life hazard. It fails, however, to protect for animal life hazard. Last winter, one of the more important members of the Code committee group stated that the animal life hazard must be handled by outside sources and specifically recommended that the wiring committee of the American Society of Agricultural Engineers set up its recommendations which could be utilized by the various forces interested. I called this to the attention of Mr. Geo. W. Kable, and I believe he presented this problem at the last annual meeting.

Any code must rule on the basis of minimum requirements and must set up guidance to permit the administrator to vary from these minimums when conditions justify or require such variation.

We have definitely proven in our own territory that the grounding called for by the Code and needed for the protection against the livestock hazard is inadequate, but that if carried out specifically, might increase the hazard. This last refers particularly to the grounding of a milking machine installation. We have provided in our recommendations an insulating joint in the pipe line of this installation, to be used in lieu of grounding.

Grounding to well casings would be allowable under the Code. However, such a ground cost us $850.00 for damages to a dairyman's herd within the last two years. We specifically recommend separate, individual grounds to be driven in the earth independent of the water system. Our reasons are that the water system is a part of the stanchion system when drinking cups are used, and naturally, then the drinking cups become a part of the cow itself when she is taking a drink. We know that cows have been killed because of short circuits in conduit systems where such systems were grounded to the water pipes, the voltage not in excess of 17 volts.

One item of considerable cost in wiring the farm is the entrance switch in excess of 60 amperes. The main cause for this is the fact that the millions of wiring jobs in the past have been 30 ampere for the majority and 60 ampere in the more rare cases, with extremely few 100 ampere. Inadequate wiring of the past has therefore failed to develop sufficient volume in the larger size equipment to permit this equipment to sell at a reasonable price.

A large percentage of farms might be served with 60-ampere entrance switches. These, however, are absolutely inadequate to serve any farm with equipment in excess of an electric range and very small motors included in the fractional horsepower group.

The most objectionable phase of the present farm electric news is that minimums for the United States as a whole are discussed. For instances, all of the REA agencies covering this area state that farm wiring can be obtained at a cost of from $1.50 to $2.50 per outlet, but they fail to know what an outlet is, and they also do not know of the necessity for adequate entrance switches and an adequate yard distribution system so that service may be extended to the several buildings on the farm.

From an engineering viewpoint then, wiring for the farm must be economical, it must be safe for livestock and human contact, and it must be protective against the fire hazard. To be any and all of these, the wiring system must be adequate to carry the loads expected on the farm.

We have few criticisms of the type of wiring and the cost of such wiring as installed on the farms in this area since 1925. Quite a few of these jobs have run up to $700.00. The ordinary farm can rarely be wired for less than $200.00. Dozens of farmers have rewired with adequate capacity and proper distribution within the last two years. The company finances wiring up to $50.00 in case the customer will install an electric range and electric water heater. It is obvious, then, that little can be done to lower the cost of wiring in this area.

In writing this, I merely want to call attention to the fact that material becoming available for discussing these problems should be studied to determine whether or not the writer is acquainted with field practices to the degree which will permit his speaking as an authority.

C. P. WAGNER

Manager, Farm Service Department
Northern States Power Company. Mem. ASAE

Facing Facts of Farm Electric Service

(Continued from page 22)

Much the same conclusion is reached in a study of the low-voltage electrical fatality record. Such accidents as do occur—and in code-making these must be evaluated in terms of the constant exposure by millions of persons on millions of installations—do not appear to be related in any way to the kind or type of wiring or even the way it is installed. They are related to carelessness and abnormal use and abuse, causes extremely difficult to control by legislation.

Because of these conditions it will be found that much of the restrictive legislation proposed in the name of public safety bears little or no relation to the statistical record of fact. No one wishes to oppose any legitimate safety measure, but it is felt that restrictions which impose excessive burdens of cost upon installation and use must be justified by actual experience. If they cannot be so justified, they are not in the public interest and operate to prevent or handicap widespread use by the public and consequent business development by every branch of the electrical industry.

The Second International Congress of Rural Engineering

By G. W. McCuen

DELEGATE TO CONGRESS REPRESENTING AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

THE SECOND International Congress of Rural Engineering held at Madrid, Spain, September 28 to October 2, 1935, was attended by 300 delegates from twenty-two countries. It was a success in every detail. The American delegation was extended every courtesy possible and were made to feel very much at home. The delegation representing America was nine in number, consisting of Dr. J. B. Davidson; Prof. and Mrs. E. R. Gross, and Mrs. McConnell, sister of Prof. Gross; Prof. and Mrs. G. W. McCuen; Mr. J. Q. McDonald, Caterpillar Tractor Company of London, England; Mr. J. Sabetier, Caterpillar Tractor Company of Paris; and Mr. Neilson, agricultural attache of Paris.

The evening prior to the official opening of the Congress the delegates were entertained with a reception at the Engineers' Club of Madrid. The club membership was made up of professional engineers and those engaged in teaching engineering. Their quarters were very beautiful. The suite of rooms was modernistic in design, lighted, and furnished modernistically. If one did not know that he were in a foreign land, he could very easily imagine it a fine club in New York or Chicago. Two of the American delegates, Dr. Davidson and Prof. McCuen, attended the reception expecting to pay their respects and return to the hotel. Much to their surprise they were greeted in English by one of the engineers, and in a short time a group of ten or more English-speaking Spanish engineers were introduced to them. Many of them were graduates of English or American universities. The evening proved to be a very enjoyable one as well as a highly profitable occasion, affording the visitors an insight to the problems of the Spanish agricultural engineers.

The Congress opened officially the morning of September 28 with Mr. G. Boukaert, president of the International Commission, presiding, and Prof. E. Aranda Heredia as secretary. The Minister of Agriculture, in the absence of the President of the Spanish Republic, gave the address of welcome. This meeting was well attended by all the members of the Congress and by members of the government service in agriculture. The Spanish press was also represented and much favorable publicity was given to the Congress as a whole.

The Spanish agricultural press had established offices, at their own expense, in connection with the Congress. In addition, various associations' officials and private organizations in the Congress were represented as well as the International Bureau of Labor, the International Federation of Agricultural Technicians, the International Institute of Agriculture, the American Society of Agricultural Engineers, and the International Federation of the Agricultural Press.

An international congress of this sort is conducted somewhat differently than what a congress would be conducted in America. More time is allowed for excursions and contacts with other adherents to the congress. So following the general assembly of the morning of the first day of the Congress, the group was broken up into sections for short sessions.

Soil Science Section. This section of science of the soil, water works, and arrangement of farmsteads, was presided over by Mr. Diserens, with Messrs. Marchesi and Delgado as vice-presidents. Messrs. Harrera and Garcia were secretaries. Mr. Blanc of France was the general reporter. Resumes of reports of various kinds were discussed and approved. Mr. Castanon gave a brief report which was well received by the Congress. It was decided by this section that, when it would be necessary to undertake irrigation work, a study should be made first of the agricultural zone before any study of the possibility of irrigation be made.

The other reports given were studied with the same interest and were approved. The reports are to be published at a later date.

Rural Construction Section. Prof. E. R. Gross (U.S.A.) acted as chairman of the section devoted to rural construction, in the absence of Mr. Arrue, agricultural engineer of Spain. Messrs. Boudry and Soroa were vice-presidents and Messrs. Alvarex Carideo and Esteruelas were secretaries. The general reporter, Mr. Castanon, gave a detailed summary of the papers presented by Messrs. Gross, Menard, Valdes, Ruiz, Sauz, and Baeschlin, and a very interesting discussion of the summary as prepared by the authors of the papers followed. The papers were unanimously approved. It was further agreed that in the future the problem of rural construction should not adapt itself to the agrarian laws, but that its aim should be to first study the possible adaptability of the buildings for the different sections of the country before recommendations were made for their use.

Agricultural Machinery and Rural Electrification Section. This section was presided over by Mr. Sourisseau of France, with others acting as vice-presidents. Messrs. Escriva de Romani and Santanaria were secretaries. Mr. Sourisseau gave a general summary of the reports presented by Messrs. Schmitz and Barando which were well received. He then gave a resume of his own personal report which aroused considerable interest and discussion. The general reporter gave a brief resume of other communications followed by a report by Prof. McCuen (U.S.A.) of the results which had been obtained in America with agricultural tractors fitted with low-pressure pneumatic tires. This subject was much discussed, and the English viewpoint presented by Mr. Denham (England) relative to rubber tires in England precipitated a lively discussion. The other reports by Messrs. Kazarow, McLibbey, Ruegger, Balzars, Murdock, Fletcher, Yerkes, Stone, Wormfelde, Davidson, Boudry, Engelhard, Blanster, Sybel and Hammer were summarized, some by the authors and others by the general reporters.

Only a brief discussion was had of rural electrification, and Mr. Manso expressed the wish that an elaborate study of rural electrification be undertaken in countries where the general distribution of electricity does not as yet exist. His discussion was unanimously approved.

Scientific Organization of Agricultural Works Section. This section was presided over by Mr. Micheli (Italy), with Messrs. Midoni, Saguira, Morales y Fraile, Fernandex de Macarrele as vice-presidents and Messrs. Oriol and Perez Calvet as secretaries.

The general reporter and Mr. Boukaert, president of the Congress, gave a summary of the reports presented by Messrs. Gutierrez Soto, Jaeger, Ineichen, Fernandex Salcedo, Mollof and Kalaptchieff, Martin Sanz, and Ilieff.

The general reporter proposed that the project submitted by Mr. Fernandez Salcedo be approved and expressed additional wishes of which the aim would be to concentrate the various opinions and tendencies of the authors regarding the rules which should regulate the rural work. A very interesting discussion took place regarding the work presented by Mr. Ineichen which cleared up several questions raised by Mr. Delgado de Tores. The conclusions of that section were approved.

Exhibits. An exhibit of photographs and drawings of the greatest interest, pertaining to the measuring instruments to be used in the dynamic study of various agricultural machines, took place during the Congress. Numerous photographs of rural Spanish constructions were exhibited and very favorably commented on.

Among the measuring instruments, the horsepower gauge is worthy to be mentioned as well as the work comptometers, the adhesion measuring instruments of the ability of compensation and the progression of the resistance on different grounds (T. Ballu), the rotation dynamometers applied to the traction wheels of track-laying tractors and also of the farming rotary implements of the Superior Institute of Portici (Italy).

Also of much interest were the graphics presented by the testing station of machinery (Madrid, Spain) pertaining to the use of olive oil to lubricate motors. The Department of Agricultural Engineering of Iowa State College also had an exhibit of work done on tractors at Ames.

Other reports receiving much attention were presented by the rural engineers of the Institute of Agricultural Research Construction for the colonization of Marocco, of Nemsa and d'Adir (Larache), those of the school of foremen of sprinkling service, of the concrete silos of the agricultural service of the Confederation of Douro, and those of the model farm of La Ventosilla (Burgos).

Besides these photographs and projects, some publications were exhibited, discussion in several languages various questions of rural engineering of which Mr. Hopfen is the author, then were given out by the International Institute of Agriculture. The Bulletin of the Spanish Committee of Scientific Organization was distributed as well as the pamphlet of a lecture on Spanish agricultural press, of Mr. de la Parra.

Receptions and Excursions. On the second day of the Congress, His Excellency the President of the Republic gave a formal reception in the Palace for the visiting members of the Congress. The Americans who had never experienced a formal reception of this kind were given quite a thrill as they passed between rows of brilliantly uniformed guards in their ap-

proach to the palace and as they wended their way up the grand stair way to the reception room. Each member of the Congress was presented by Mr. Heredia to the President and then was conducted to the large ballroom where refreshments were served. It was an extremely enjoyable evening, and it was with regret that the affair was brought to a close.

Excursion to Old Toledo. The Congress made arrangements to take all of the delegates on a day's excursion to old Toledo where many of the interesting buildings and cathedrals of the old Spanish civilization were visited. On the arrival at Toledo the group left the buses and started on a walking tour about the city. They observed the old cathedral built in the early centuries and following that was a visit to the synagogue where the Moors worshipped when they occupied Spain. A visit to the house of great Gregro (Spanish artist) gave an insight to the life of the artist when he lived there in the fifteenth century. His home was well preserved as were many of his fine painting which were mostly ecclesiastical.

At noon a five-course luncheon was served at the hotel at Toledo, and the afternoon was spent in the old cathedral de la Toledo. This was the most ornate of all the cathedrals visited. Beautiful carvings in wood and stone and superb paintings were seen in practically every quarter of the old cathedral. The church treasuries, too, were beautiful and had the appearance of being very costly. If one were a connoisseur of tapestry art, a very profitable afternoon could be spent, for the old tapestries were beautifully kept and well preserved in the cathedral.

Prior to the return to Madrid the group entertained themselves by taking liquid refreshment at the sidewalk cafes. (Liquid refreshments for the American delegates consisted of lemonade.) The trip back to Madrid was very interesting, as it was in the hour of the day when the vistas were constantly changing due to the beautiful glow of the sunset over the hills. In the evening the delegation was entertained at the city hall with a concert by the municipal band. If one were not a lover of Spanish music, he would not be indifferent to it after the fine rendition of difficult pieces played by the band. Refreshments were served following the concert.

One very interesting visit was made by the delegation to the national agricultural institute of La Moncola at Madrid. Mr. Heredia, secretary of the Congress, is professor of agricultural engineering at this institute. The delegates spent a very profitable afternoon at the institute and saw the importance that was being given to agricultural engineering in Spain. It was learned that much of this recognition has come through the fine efforts of Prof. Heredia and has come about in the past six years. There was a very complete exhibit of agricultural machines, research laboratories, and especially fine hydraulic equipment. A great number of models and various reproductions received many compliments from the foreign specialists.

One of the interesting pieces of work being done was the use of olive oil in the lubrication of internal-combustion motors.

Excursions of great touristic interest took place in the surroundings of Madrid and at the same time the organization committee did not neglect to attract the attention of the visitors and the progress realized by the rural engineers in Spain. The irrigated zones of the lower valley of Guadalquivir were visited as well as the cotton mills of Tabladilla, the investigation center of tobaccos of Santiponse (Seville), the irrigation work of High Aragon, Arguis's Dam (Huesca), the orange groves of Alcira, and the rice plantations of Albourera. The excursionists were able to appreciate the great efforts realized by Spain to improve her agriculture.

The Banquet. The banquet of the Second International Congress of Rural Engineering was the high light of the entertainment of the delegates. At a late hour, 10:30 p.m., the delegates assembled in the banquet hall of the Palace Hotel and were given a treat in the way of a most satisfying and beautifully served meal. The banquet was formal in all respects. Again, if one were not cognizant of the fact that he was in a foreign country, it would be hard to realize that this was a foreign banquet. The delegates and ladies were formally attired and presented a very interesting picture. The one thing that seems to be international in all respects is formal dress. Following the banquet, there was dancing, and again the music and dance steps were practically the same as would be found in any first-class hotel in America.

General Impressions. The idea of having the Second International Congress of Rural Engineering meet in Spain was given the hearty approval of all. The efforts to attract technicians of many countries was a worthy one. In Spain, which is a country quite comparable to Mexico and southern California, the delegates learned much about the problem that confronts the Spanish agriculturist and rural engineer. Much was learned about the possible uses of electricity in connection with irrigation in these countries. The Spanish technicians gained much respect from foreign professional men, and it is quite proper to say that the Spanish engineers were found not to be inferior to the technicians of other countries. Much credit must be given to the Spanish agricultural press, and the International Federation of Agricultural Presses recommended that the agricultural press of all countries present in as clear a way as possible the works of importance which have international aspects. The favorable publicity given by the Spanish agricultural press was commented upon by the delegates.

It is the feeling of those who attended the Congress that much credit must be given to the untiring efforts of Prof. E. Aranda Heredia in making the Congress such an outstanding success.

THE GROUP WHICH ATTENDED THE SECOND INTERNATIONAL CONGRESS OF RURAL ENGINEERING AT MADRID, SPAIN

NEWS

Southern Agricultural Engineers Meeting Program

AS USUAL the Southern Section of the American Society of Agricultural Engineers will meet coincidentally with the Southern Agricultural Workers Association, at the Edwards Hotel, Jackson, Mississippi, February 5, 6, and 7. It is quite possible that the agricultural engineers' program will be sponsored jointly by the Southern and the Southwest Sections of the Society. Due to the fact that the forenoons of the dates named are devoted to general sessions of the SAWA, the agricultural engineers will hold their sessions on the afternoon of each day.

The program for the afternoon of Wednesday, February 5, will feature soil and water conservation. For this session the provisional program includes a paper on the soil conservation program in the Southeast to be presented by T. S. Buie, regional conservator of the USDA Soil Conservation Service. This will be followed by a paper to be presented by Ralph W. Baird, agricultural engineer of the SCS, on terracing equipment and terrace construction practice. Another paper on the subject to be presented by M. L. Nichols, head of the agricultural engineering department, Alabama Polytechnic Institute, will be devoted to the subject of the engineering phases of soil erosion control. A fourth paper at this session will deal with soil conservation camps, a speaker for which had not been selected at this writing. The presentation of these papers will be followed by round table discussion.

The afternoon session of Thursday, February 6, will be devoted to a general program headed by an address by L. F. Livingston, president of the American Society of Agricultural Engineers, which will deal with the subject of timely and outstanding interest to agricultural engineers. Two technical papers have been scheduled for this session, one on new developments in rural electrification by D. S. Weaver, agricultural engineer, North Carolina State College, and the other on progress in the development of a $300.00 hay drier, by J. W. Weaver of the Tennessee Valley Authority. The session will close with a business meeting.

The program for Friday afternoon, February 7, will consist of a symposium on new developments, which will be divided into four sections. The first section on teaching methods will be led by W. N. Danner, Jr., agricultural engineer, University of Georgia, followed by prepared-in-advance discussions by A. Carnes, Alabama Polytechnic Institute, on vocational education; by C. E. Seitz, Virginia Polytechnic Institute, on agricultural engineering; and by U. H. Davenport, University of Georgia, on general engineering. The second section will be devoted to agricultural engineering extension for 1936, led by S. P. Lyle, senior agricultural engineer (extension) USDA Bureau of Agricultural Engineering. This will be followed by prepared-in-advance discussions by G. I. Johnson, University of Georgia, on methods, by C. J. Hutchinson, Louisiana State University, on procedure; and by J. T. Copeland, Mississippi A. & M. College, on resettlement. The third section will deal with research procedure and will be led by M. L. Nichols, Alabama Polytechnic Institute, followed by prepared-in-advance discussions by J. W. Randolph, USDA Bureau of Agricultural Engineering, on soil dynamics, and A. T. Hendricks, agricultural engineer, University of Tennessee, on a new electric feed grinder for southern farm conditions. The fourth and last section will be devoted to commercial activities and will be led by W. A. Clegg, agricultural engineering, Caterpillar Tractor Company, with prepared-in-advance discussions by W. B. Alford, E. I. du Pont de Nemours & Company, on explosives; Fred B. White, Tennessee Coal, Iron and Railroad Company, on structures; and George W. Kable, Tennessee Valley Authority, on electrical equipment.

The officers of the Section, consisting of R. H. Driftmier, head of the agricultural engineering department, University of Georgia (chairman), D. S. Weaver, agricultural engineer, North Carolina State College (vice-president), and G. I. Johnson, extension agricultural engineer, University of Georgia (secretary), extend a cordial invitation to all agricultural engineers and others interested in their program to attend the meeting.

Nominations for 1936-37 ASAE Officers

THE Nominating Committee of the American Society of Agricultural Engineers—L. J. Fletcher (chairman), Wm. Boss, and C. E. Seitz—has placed in nomination the following members in connection with the annual election of officers for the year 1936-37:

For President

RALPH U. BLASINGAME, professor of agricultural engineering, Pennsylvania State College

For First Vice-President

L. G. HEIMPEL, professor of agricultural engineering, Macdonald College (Quebec)

S. P. LYLE, senior agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture

For Second Vice-President

A. W. FARRALL, research engineer, Creamery Package Mfg. Co.

A. W. TURNER, International Harvester Co.

For Treasurer

RAYMOND OLNEY, secretary of the Society

For Councilor

O. W. SJOGREN, agricultural engineer, Killefer Mfg. Corp.

H. B. WALKER, professor of agricultural engineering, University of California.

For Nominating Committee

WALLACE ASHBY, USDA Bureau of Agricultural Engineering

E. E. BRACKETT, University of Nebraska

J. B. DAVIDSON, Iowa State College

G. W. KABLE, Tennessee Valley Authority

H. B. ROE, University of Minnesota

F. A. WIRT, J. I. Case Co.

The by-laws of the Society provide that 30 days shall be allowed for additional nominations by special nominating committees, at the expiration of which period (on February 20) the Secretary of the Society will mail letter ballots to all voting members.

Washington News-Letter

THE following news from Washington is furnished by American Engineering Council:

"The Engineers' Relations to National Development" and "Economic Status of the Engineer" will be the two major topics of the annual meeting of American Engineering Council, January 9, 10, and 11. Under these major themes will be grouped the reports of Council's committees on public affairs and of the special and standing committees of Council. Last year the heads of government agencies, old and new, presented to the delegates the various ways in which the engineering profession could cooperate in the emergency conditions in the vertical fields of government relations to manufacturing (NRA), public works (PWA), relief (FERA), and several other subsidiary subjects.

This year what may be said to be two horizontal slices of government activities will be presented both by representatives of the government and by chairmen of standing and special committees of Council. One of these slices will concern itself with the public values of the engineer's part in national development, such as public and private construction, development of water resources, mapping and surveying, rural electrification, patent legislation, and so forth. The second slice will deal with such questions as the survey of engineers, the merit system, engineers' compensation in government service, government competition with private engineering practice, etc.

The second report of the Science Advisory Board, established by executive order of President Roosevelt in July 1933, under the National Research Council created by Congress at the request of President Wilson in 1918, has just been published. Like the National Resources Committee, it addresses itself to certain problems of national development in which the engineer and scientist have a part. The report of the National Resources Committee which has been transmitted to our members in sections as a part of the semi-monthly "Embassy Service" relates itself to the broader prob-

lems of the planned technical, social, and economic development of our national resources. Like the National Resources Committee, the Science Advisory Board has no authority for action. It may only recommend. Both reports attempt to give broad direction to national policies, the one emphasizing the values of a planned approach to national development and the second concerning itself with the relating of government to effective research and what may be called the "tools" of planning.

The general report of the Science Advisory Board covers such subjects as the national dependance on science, the need for a science advisory service to government, and the future development of a science advisory service. It recommends, first, that a body be set up under the National Academy of Sciences to succeed the present reporting board, and, second, that the responsible government officers and this new board continue to seek the solution of the problems which have been reported upon.

The second part of the report deals with the reorganization and reconsideration of certain of the scientific branches of the government, including the Weather Bureau, the Bureau of Chemistry and Soils, the surveying and mapping services of the federal government, the relation of patents to new industries, and a dozen other reports of inquiries into the purposes and the efficiency of present government undertakings.

Once again the necessity as well as the desirability of a basic mapping program is projected in this report. The scientists and engineers who made this latest recommendation have done so as the request of the Bureau of the Budget. Under the chairmanship of Douglas Johnson, professor of physiography, Columbia University, a committee of seven geographers, geologists, and engineers have presented the results of six months of intensive study of 28 federal agencies engaged in surveying and mapping and upon recommendations of the Federal Board of Surveys and Maps. The report, after emphasizing the many values in such a program already well known to members of American Engineering Council, recommends that an agency known as the "U. S. Coast and Interior Survey" be set up either as (1) an independent establishment reporting to the President, (2) as a unit of the Department of the Interior, (3) as a unit of the Department of Commerce. The present director of the Coast and Geodetic Survey of the Department of Commerce is proposed as the head. The new agency would comprise the following: (1) The Coast and Geodetic Survey, (2) the Topographic Branch and the Division of Engraving and Printing of the Geological Survey, (3) the International (Canada) Boundary Survey, and (4) the Lake Survey. The committee recognizes the individuality and purposefulness of many subsidiary mapping services.

The plan, as proposed in general, has the support of all the agencies concerned. It was recommended that the consolidation proposed be brought about by executive order, but it is our understanding that the President no longer has this power, so that action rests on congressional consideration.

Thus one more non-partisan and able effort to affect a much desired result calls for a further follow-through plan.

In November the Federal Board of Surveys and Maps requested the American Engineering Council to undertake to coordinate the opinion of map users on the need for the basic mapping program. A proposal for action will be presented at the annual meeting of the Council on January 9, 1936.

Early arrivals to Congress seem agreed that there must be less spending, better planning of what is spent, and that there must be a shift from government to private employment. Relatively small employment gains have been made outside of government. Millions are still dependent upon government. It is very difficult to get true figures. Industry, it is estimated, has absorbed about a million, and hundreds of thousands have found work in other phases of business. The Bureau of Public Roads reports five million man-months employment in the federal highway program for the fiscal year ending June 30, 1935, financed from 1934 and 1935 emergency funds. They state that farm-to-market roads, grade-crossing elimination, and expanded highway construction are progressing at a rate which indicates they may exceed last year's expenditures and also employment.

California Also

IT WILL be of interest to agricultural engineers to learn that the University of California has been notified that its agricultural engineering curriculum has been fully approved as an engineering curriculum by the University of the State of New York, thus permitting graduates to be admitted to the licensing examination and practice of professional engineering in the State of New York.

ASHVE Meeting in Chicago

LEADERS of the heating, ventilating, and air-conditioning profession and allied industries will gather at the 42nd annual meeting of the American Society of Heating and Ventilating Engineers to be held at the Palmer House, Chicago, the week of January 27. Some of the leading subjects for discussion at this meeting include conductivity of concrete, corrosion in steam heating systems, influence of storm sash on fuel saving, heat transfer through finned surfaces, desirable air quantities, and summer comfort standards. Coincident with this meeting the 4th international heating, ventilating, and air-conditioning exposition will be held at the International Amphitheatre, with displays by more than 200 industrial firms showing the latest developments in the field of heating, ventilating, air-conditioning, refrigeration, piping, and allied products and supplies. The ASHVE extends a cordial invitation to all who are interested in heating, ventilation, and air conditioning, to attend this meeting. Further information regarding it may be obtained from the headquarters of the Society at 51 Madison Ave., New York, N. Y.

Iowa State Branch News

THE agricultural engineers at Iowa State College had the honor of placing in the Knights of the Guard of St. Patrick (engineering honorary) two men, Philip Brintnall and William H. McConnell. These men are chosen from among the outstanding seniors in the engineering division. The pledging took place at the Engineers Carnival held November 16, and one of the total of twenty-five men will be chosen by popular vote to represent St. Patrick himself, and which will be announced at the Engineers' Ball on February 1.

At our last monthly meeting, B. J. Firkins, associate professor of soils, Iowa State College, gave us a very interesting talk on the soil erosion situation in Iowa. He stressed emphatically the practical side of our erosion program and outlined what could actually be done in the state to improve the situation. He gave some very interesting reports of the results of different methods of erosion control as practiced at the soil erosion control station at Bethany, Mo.

Seven undergraduates and two research fellows, together with six of our faculty members, attended the division meetings of the ASAE which were held in Chicago the first week in December. We are rather proud of the fact that we had the largest number of students in attendance of any one school represented at the meeting, and are looking forward to having an even better turn-out at the June meeting.—George Dunkelberg, scribe.

A Correction

Under the heading "Personals of ASAE Members," on page 493 of AGRICULTURAL ENGINEERING for December, it was erroneously stated that M. W. Nixon is assistant research professor of plant pathology at New York State College of Agriculture. His correct and only title and connection is "rural service engineer, Empire State Gas and Electric Association."

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Jack W. Austin, advertising manager, The Sisalkraft Company, Chicago, Ill. (Mail) 6342 N. Oakley Ave.

J. Reid Bishop, senior foreman, Soil Conservation Service, U. S. Department of Agriculture. (Mail) LeRoy, Ill.

M. S. Blackwell, electrical engineer, Central Illinois Electric and Gas Company, Lincoln, Ill. (Mail) 628 Broadway.

Gustave H. Bliesner, farm electrification agent, Puget Sound Power and Light Co., Mt. Vernon, Wash. (Mail) 720 N. 6th St.

Edwin W. Eden, Jr., junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 244 Benner St., Highland Park, N. J.

M. G. Huber, instructor in agricultural engineering, Pennsylvania State College, State College, Pa. (Mail) 439 E. Foster Ave.

Orrin K. Howe, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Channing, Tex.

Ernest H. Kidder, senior foreman, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box D, Lanesboro, Minn.

M. E. Mouser, camp engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 263 W. Main St., Carrollton, Ohio.

I. L. Saveson, associate technician, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 681 Malvern Ave., Columbus, Ohio.

Loyd E. Shirley, vice-president and chief engineer, The C. S. Bell Company, Hillsboro, Ohio.

Elmer T. Wible, advertising manager, Pittsburgh Steel Company, Pittsburgh, Pa. (Mail) Box 118.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

HOME ARCHITECTURE, *R. Newcomb* and *W. A. Foster*. New York: John Wiley & Sons. London: Chapman & Hall, 1932, pp. XIII + 336, figs. 238. This is a handbook for the home designer based upon experience at the University of Illinois. It contains chapters on the history of shelter, the development of the house in America, the home site, house plans and planning, materials of construction, types of house construction, interior finish, home decoration and furnishing, plumbing, heating and ventilation, lighting, mechanical household appliances, ownership, tenancy, financing the home, why employ an architect, building the new house, remodeling the house, the apartment house, the farmhouse, and the home grounds.

A STUDY OF THE BEHAVIOR OF THE WATER TABLE IN UNDERDRAINED AND SURFACE-DRAINED RIVER VALLEY SOILS IN QUEBEC, *R. Millinchamp*. Sci. Agr., 15 (1935), no. 9, pp. 625-632, figs. 6. This is a progress report of investigations at Macdonald College which relate to the influence of drainage on the water table in soil and in turn its influence on root development of forage and other crops.

The data are presented graphically for the four experimental plats, and in general indicate the ability of the tile drains to lower the water table. Further objectives of the study are to determine optimum depth and spacing of tile drains and the physical characteristics of the soils and subsoils of typical heavy river valley lands.

AN IMPROVED TYPE OF HOG PEN, *S. M. M.* Hawaii. Planters' Rec., 39 (1935), no. 2, pp. 141-143, pls. 2. An improved type of hog pen is illustrated. The building contains 22 pens each, 6 by 8 feet.

HOUSING, LABOR-SAVING EQUIPMENT, AND MANAGEMENT PROCEDURES FOR LAYERS, *D. C. Kennard* and *V. D. Chamberlin*. Ohio Sta. Bimo. Bul. 174 (1935), pp. 108-112, figs. 2. Practical information on the subject is given.

HOW TO LAY AND MAINTAIN LINOLEUM, *C. H. Jefferson*. Michigan Sta. Quart. Bul., 17 (1935), no. 4, pp. 182-185. Practical information is given.

STUDIES ON THE SURVIVAL OF B. TYPHOSUS IN SURFACE WATERS AND SEWAGE, *H. Heukelekian* and *H. B. Schulhoff*. New Jersey Stas. Bul. 589 (1935), pp. 32, figs. 13. Studies of the survival of *Bacillus typhosus* in different artificially infected substrates under various environmental conditions using brilliant green agar for the enumeration of the numbers are reported which was further extended to the presence of *B. typhosus* in sewage and the survival in sewage treatment processes.

It was found that the rate of decrease of *B. typhosus* in polluted water and sewage is rapid. Several days' storage will result in a 99 per cent reduction with a heavy initial infection. The rate of decrease is affected materially by the temperature, being greater at a temperature of 22 degrees and 37 degrees Centigrade than at 2 degrees.

An actual multiplication of *B. typhosus* with favorable temperatures and in the presence of food supply may take place. This multiplication, however, does not necessarily result in an increase in the survival time, as the rate of decrease after the multiplication stage is greater than without an initial multiplication. The addition to unpolluted water of small amounts of feces, urine, sewage, and broth, and the food carried over in the inoculum from broth culture and agar slants results in actual multiplication. The magnitude of the multiplication is dependent on the amount of food added. In polluted waters the survival of *B. typhosus* is shorter than in unpolluted waters, probably because of the competition for food from other bacteria and because of protozoan attack. Aeration reduces the survival time of *B typhosus*. Under starvation conditions the presence of B. coli does not affect the death rate of *B. typhosus*. The survival time of *B. coli* is not affected by the presence of *B. typhosus*. In the presence of food supply the survival time of *B. typhosus* is reduced by the introduction of *B. coli*. The addition of flavobacterium increases the longevity of *B. typhosus* probably as a result of food made available by the former.

When a normal domestic sewage is sterilized with heat and infected with *B. typhosus* a rapid increase occurs initially. With certain sewages containing industrial wastes the initial increase does not take place and the survival time is greatly reduced. With various municipal sewages no successful isolation of *B. typhosus* takes place during the anaerobic digestion of sewage solids. When present in activated sludge-sewage mixtures the numbers of *B. typhosus* increase initially (4 to 6 hours). The increase is greater when no air is passed. There is a very rapid reduction of the number of *B. typhosus* in the activated sludge mixtures after the initial increase, especially in the presence of air. When artificially infected sewage is chlorinated partially, the destruction of *B. typhosus* is of the same order as the destruction of the normal sewage flora. When only 25 per cent of the chlorine demand was satisfied there was over 99 per cent reduction of *B. typhosus* in 10 minutes contact time.

THE ECONOMIC RELATION OF TRACTORS TO FARM ORGANIZATION IN THE GRAIN FARMING OF EASTERN WASHINGTON, *E. F. Landerholm*. Washington Sta. Bul. 310 (1935), pp. 51, figs. 13. The purpose of this publication is to point out the trends in the use of horse and tractor power in the grain farming areas of eastern Washington, to aid the wheat farmers of this region in obtaining maximum efficiency in their field operations, and to impress upon manufacturers and dealers the need of supplying proper equipment to meet the particular needs of farmers who operate the wheat farms of the Pacific Northwest and of other farmers growing wheat in areas with rolling topographies. The field data for this study were obtained by a combination of record keeping by the cooperating wheat farmers, and a survey.

The area studied embraces the wheat region of eastern Washington, consisting of the Palouse or more humid and rolling region on the east and the Big Bend or dry, level, or gently rolling region on the west.

It was found that there is considerable duplication of machine and animal power, the animal power often being unused. Available animal and machine power have been duplicated to such an extent that even with improved farm machinery the number of acres now farmed per unit of power is less than in 1910. Tractor operated farms are considerably larger than the average according to the census. Out of 56 farmers who had changed wholly from horses to tractors, 23, or 41 per cent, had enlarged their farms. As a result of changing from horses to tractors, 37 per cent of the farmers interviewed had rented additional land. The larger the farm, within reasonable limits, the more efficiently can the tractor be utilized. The same is true of horses but to a less marked degree. Tractors have a greater potential capacity for work than do horses if one compares one horsepower to one horse, but this potential capacity often goes unused.

Tractors are comparatively less efficient than horses on small farms and comparatively more efficient on large farms. Similarly, tractors as compared to horses are comparatively less efficient on hilly land than on level land. On 56 farms that had changed wholly from horses to tractors it was found that on hilly land an average of 35 acres was farmed per horse and 31 acres per horsepower. On level land 53⅔ acres were farmed per horse and 55½ acres per horsepower.

The average costs of the various field operations on level land were between two-thirds and three-fourths of the cost on hilly land. On hilly land with 30-hp tractors five 14-inch plows gave the most efficient results from the standpoint of acreage covered and of low cost. On level land six 16-inch and seven 14-inch plows gave the best results. On hilly land, harrows 48 to 50 feet in width were the most efficient; on level land this width increased from 60 to 66 feet. For weeding hilly land, weeders 24 to 36 feet in width were most efficient; on level land 30 to 36 feet. For seeding hilly land, drills 21 to 24 feet in width were most efficient; on level land this width increased to 25 to 33 feet. The most efficient width of harvester (cutter bar) was 14 and 15 feet for hilly land and increased to 20 feet on level land. Where the cost of operating the combine was added to the tractor cost the difference in per acre cost of combining at the rate of 18 as compared with 25 acres per day was found to be about 90 cents per acre.

An appendix gives tabular data.

Low Cost Homes from Small Logs

(Continued from page 20)

with the rough floor of home-sawed lumber. The split-log walls and partitions require some sawing and nails, but these are both small items. Either edged poles or home-sawed lumber may be used for rafter and ceiling joists. Roof boards may be of rough lumber. Items to be purchased consist of windows, doors, frames and trim, shingles, finish floor, ceiling (¼-inch plywood and 4 inches of dry shavings or sawdust), inside wall lining of ¼-inch plywood, building paper, chimney material, and hardware. In addition to offering a low-cost type of building construction, it also creates a use for the one forest crop that will be ready for harvest during the next 25 years, while the slower starting and growing trees are reaching useful sizes.

In order to popularize this type of construction, a series of attractive ripped-log house designs for farm home and resort purposes were prepared and incorporated in a University of Wisconsin publication, entitled "Log Buildings." In addition to this, the Forest Products Laboratory made a model of one of the designs from 2-inch poplar poles to quarter-inch scale. This has been widely exhibited.

Last fall and winter, the Wisconsin Rural Rehabilitation Administration purchased poplar stumpage and set up logging camps where transient labor was supplied without cost and sufficient logs were taken out and sawed to build about twenty sets of farm buildings. Sales of wood not suitable for split-log construction paid for the stumpage.

It is hoped that the new resettlement organizations will find it possible to move isolated settler from restricted-use districts, reducing fire hazards in forestry districts and excessive road and school costs. Homes of ripped logs make this shift possible at reasonable cost and will provide sturdy, lasting homes which harmonize in an architectural way with this rugged countryside.

Corrections

In the article, entitled "Cooling Milk with Ice," by John E. Nicholas, appearing in AGRICULTURAL ENGINEERING for December, a typographical error occurs under the subtitle "Conclusions," on page 474. Item 2 reads "The dry type tank must be reiced more frequently, etc." It should read "The *wet* type tank must be reiced, etc."

In a review of the book, entitled "Rural Electrification," by J. P. Schaenzer, appearing on page 502 of AGRICULTURAL ENGINEERING for December, it was stated that the book contained 59 pages. It should have read "259 pages."

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS WANTED

AGRICULTURAL ENGINEER with master's degree in agricultural engineering, and additional training in fundamental sciences, desires position in either teaching or research work. Eight years' experience. Age 32. Married. PW-267.

POSITIONS OPEN

ENGINEER (preferably agricultural) is offered considerable block of non-assessable stock in a close corporation which controls through strong patents, etc., the manufacture and sale of practical concrete construction specialties of proved utility. This stock can be paid for by development work that need not interfere with the engineer's usual activities. To an ambitious engineer having executive ability, this offers an opportunity to become a high official of a corporation that in due time should become a strong, nationally known firm. PO-112